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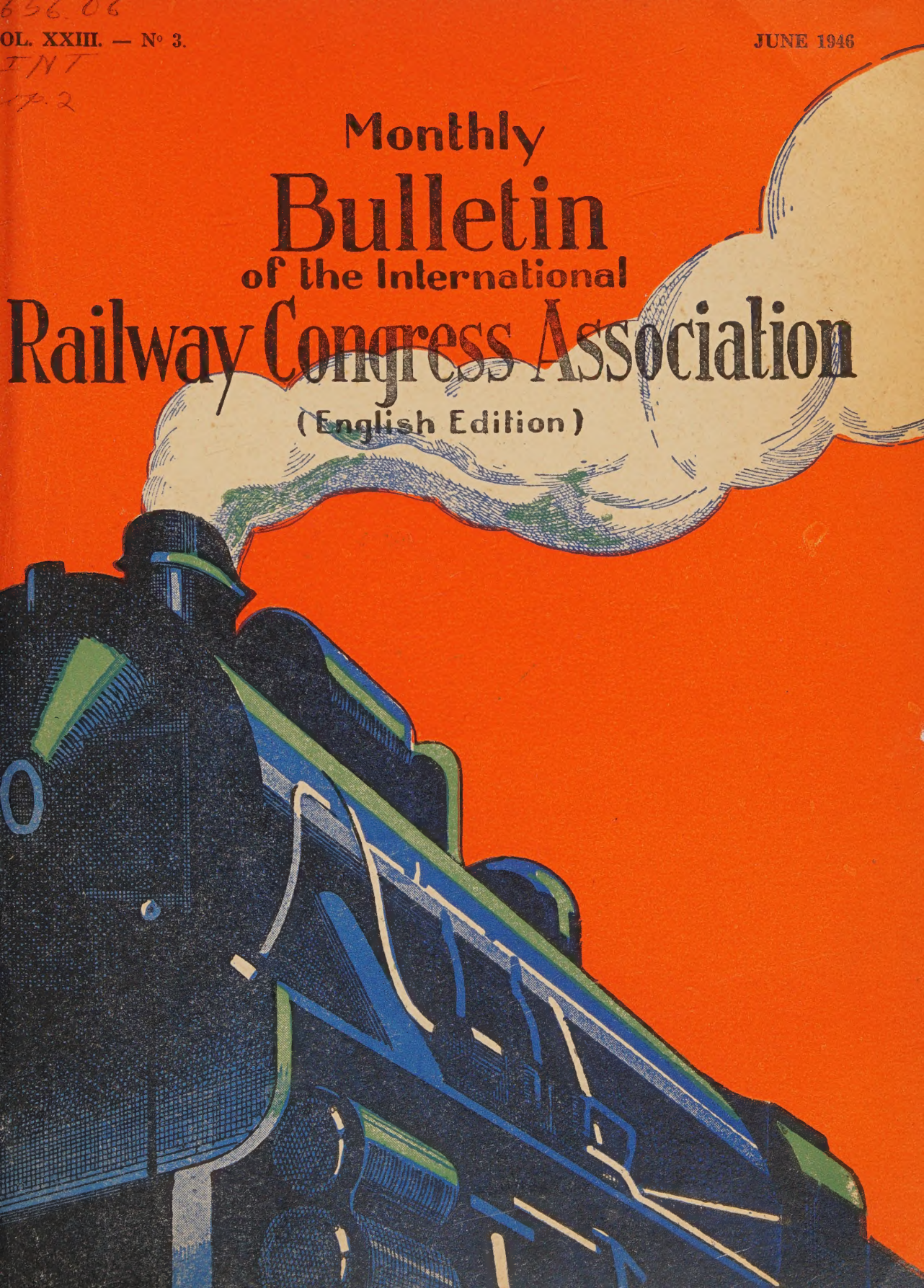
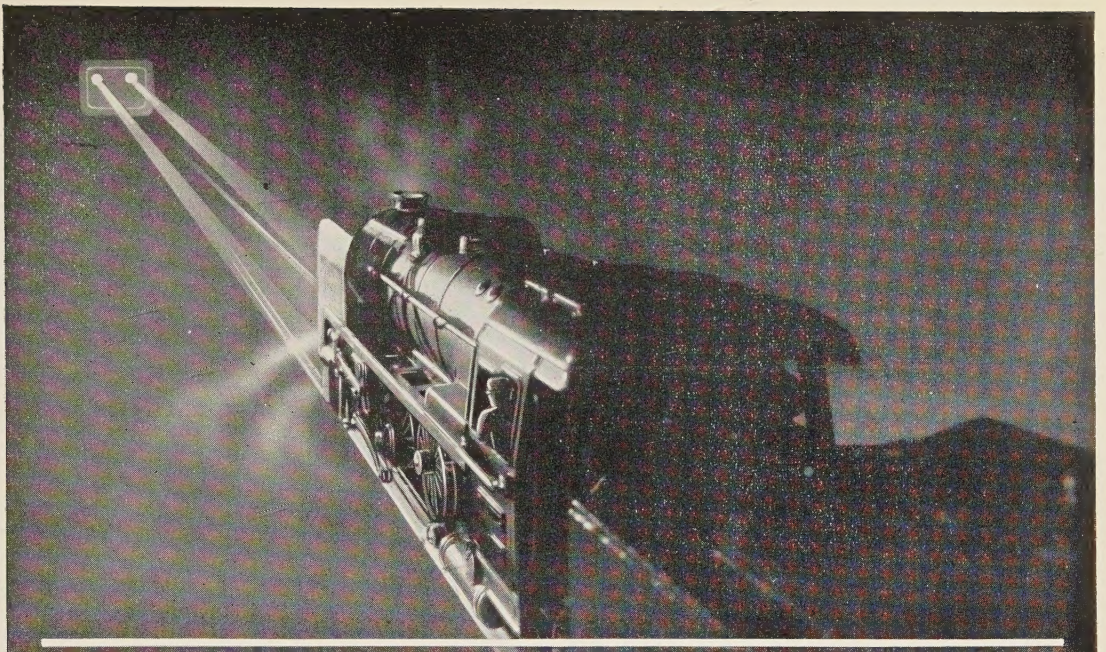
Monthly Bulletin of the International Railway Congress Association

(English Edition)





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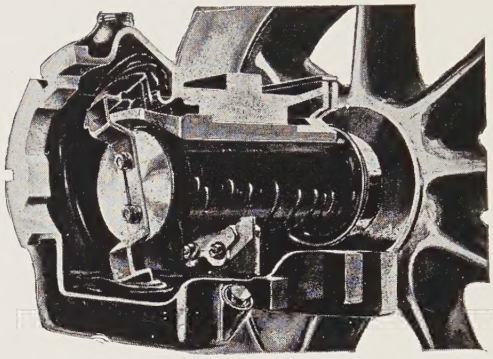

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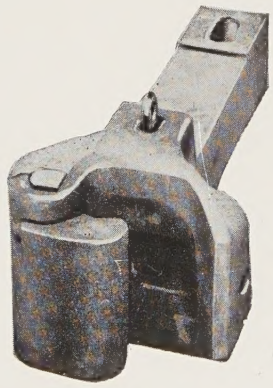

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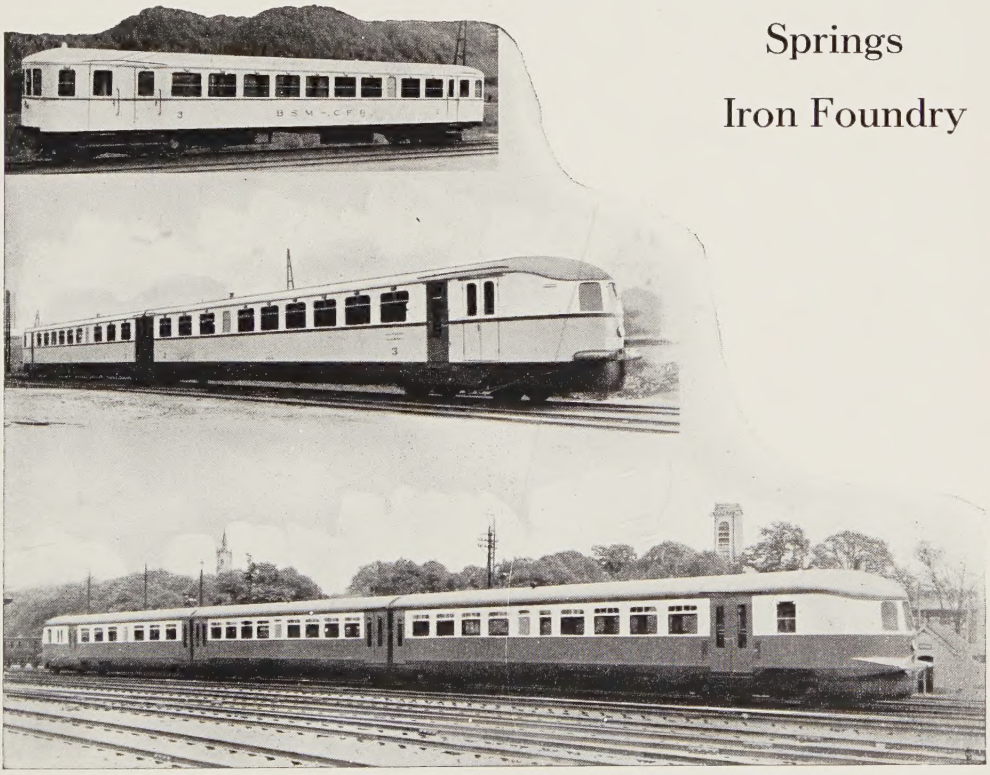

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MONTHLY BULLETIN

OF THE

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(ENGLISH EDITION)

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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[621. 132. 3 (.42)]

Pacific locomotives on the Southern Railway,

by O. V. S. BULLEID,
M. I. Mech. E., Chief Mechanical Engineer, Southern Railway.
(Modern Transport.)

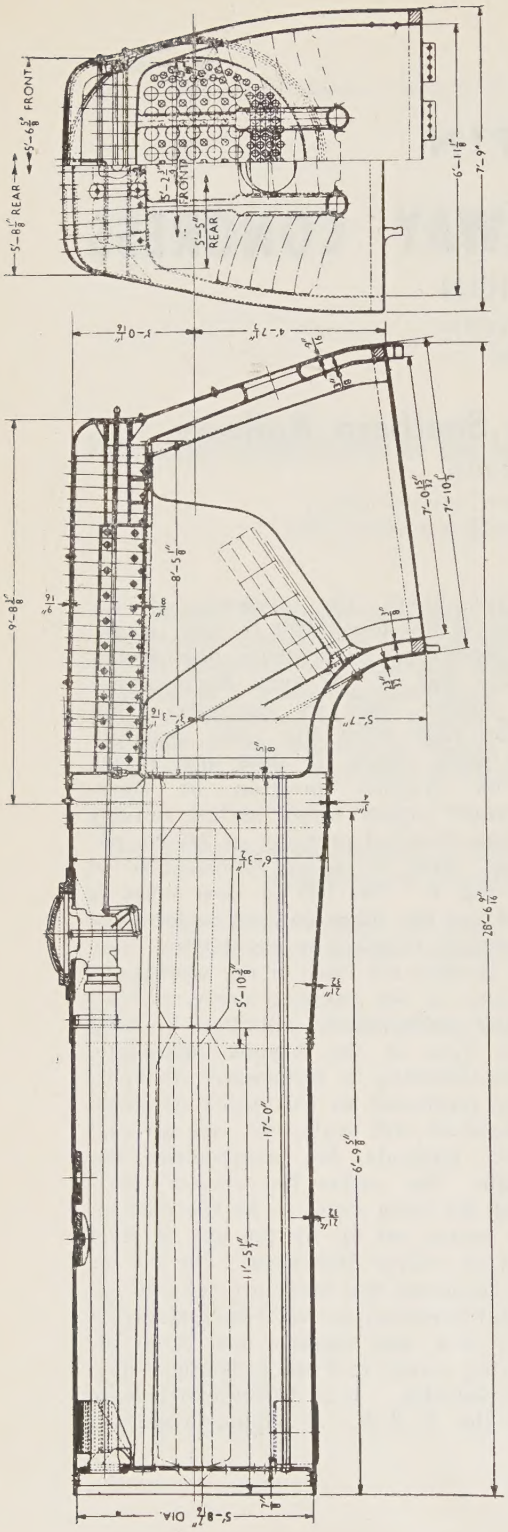
I. — Design and construction of the Merchant Navy Class.

The requirements of the Southern Railway, which led to the building of the Merchant Navy class 4-6-2 locomotives, were for an engine capable of maintaining a 60 m.p.h. average speed on short runs, as to Dover, or 70 m.p.h. on longer runs as on the Exeter road, and of a maximum of 90-95 m.p.h. Passenger trains of 550-600 tons had to be regarded as probable in the near future. The pressure of 280 lb. per sq. in. was adopted instead of 220 lb., the highest hitherto in use on the Southern Railway, in order to limit the cylinder dimensions. This pressure approaches the limit for simple-expansion engines, especially when the engine is working at a very early cutoff and with reduced steam chest pressure and severe wire-drawing of the steam.

Steel *versus* copper.

The Non-Ferrous Metals Research Association's investigation into the corrosion of copper firebox plates and the wasting away of the staybolt heads showed clearly the unsuitability of arsenical copper for the temperature of 390 deg. F. recorded in the ends of the stays, the pressure of the boiler tested being 220 lb. per sq. in., corresponding to a steam temperature of 395 deg. F. At such temperatures the copper loses its elasticity. This means that after the plate expands, and cools down, it does not return to its original position or form. Arsenical copper would be less suitable for the intended pressure of 280 lb. per sp. in. with its steam temperature of 416 deg. F. The life of steel tubes is short and the tubes have to be renewed frequently, mainly through pitting; they give trouble not only in the workshops but also in the running sheds, as they require considerable attention to keep them tight in the firebox tube-plate. Water-softening in hard-water districts, water treatment in soft-water districts, removal of mill scale, etc., are all suggested methods for overcoming the trouble. The author has always considered the main cause to be the electrolytic action set up by the use of steel tubes in copper fireboxes. The use of steel fireboxes was therefore considered.

Steel fireboxes are used exclusively in the U. S. A. and Canada, and to an increasing extent in France, South Africa, and Australia. It is difficult to believe that the U. S. A., a copper-producing



Longitudinal and cross-sections of the boiler and firebox, fitted with Nicholson thermic syphons, on the Merchant Navy class Pacific locomotives designed for the Southern Railway by Mr. O. V. S. Bulleid.

country, would persist in using steel if this material were really unsatisfactory. It is often stated that steel can be used for wide fireboxes, but not narrow, but steel was used in the U. S.A. before the introduction of the wide firebox.

Steel fireboxes were said to be unsatisfactory owing to the plates cracking. Copper fireboxes, however, are not immune from this trouble. There had been no experience of steel fireboxes in England in recent years and it was known that firebox steel plate had improved in quality. A special firebox plate manufactured by one steel maker is better than anything available previously. The analysis of this plate is : carbon 0.15 per cent. max., manganese 0.55 per cent. max., phosphorus and sulphur 0.03 per cent. max. The mechanical properties are : ultimate tensile strength, 24 to 28 tons per sq. in., elongation on 8 inches, 25 per cent. min. The analysis of the standard American firebox plates is : carbon 0.25 per cent. max., manganese 0.3 to 0.6 per cent, phosphorus and sulphur 0.04 per cent. max., with similar mechanical properties.

This new plate is almost free from creep, a great merit in firebox plate. It is also readily weldable and a completely welded firebox, both inner and outer, was a pratical possibility in view of the development of electric welding. As riveted joints would be suppressed there would be no double thickness of metal to cause trouble through overheating and burning away. Moreover, should any cracks develop there would be no difficulty in cutting out the defective piece of plate and welding in a new piece of plate, an operation that would take little time and could be done in position. The use of steel would effect a large reduction in weight as compared with copper, which in the case under consideration would be at least 1 ½ tons. During the war, too, anything that would reduce the use of copper

was desirable. The use of steel fireboxes on recent French locomotives with 280 lb. per sq. in. pressure and over had been satisfactory, and, in fact, the author found the French engineers convinced that for such pressures steel fireboxes must be used.

The successful introduction of the Nicholson thermic syphon had provided a reliable means of improving the boiler circulation, whilst, at the same time, giving added security against overheating of the crownplate. It seemed reasonable to expect good results from steel fireboxes provided that care was taken in the design to allow for the differences between steel and copper, and also that all reasonable precautions were taken to ensure that the fireboxes were treated with proper care in service. It was therefore decided to use steel fireboxes on these locomotives.

The boilers of the first ten locomotives were built by the North British Locomotive Co., Limited, and the author is much indebted to Mr. Lorimer and Mr. Black for their help in their design and manufacture. The subsequent ten boilers have been produced in the Southern Railway workshops at Eastleigh. All the plates of the outer firebox, comprising the back plate, wrapper and throat plate, are welded together. The outer box is riveted to the Belpaire ring. The inner firebox plates, comprising back plate, wrapper, throat plate and tube plate, are also welded together, the top flanges of the two syphons being welded into the roof of the firebox. The inner and outer fireboxes are welded together at the firehole. For practical reasons the inner firebox has to be inserted through the foundation ring opening, and the shape of the inner box has to be checked to ensure that this is possible.

Welding procedure.

All holes in the pressed plates are drilled before the plates are assembled together. In the case of the wrappers, the plates are drilled on the flat before bending, as are the barrel plates before rolling, an advance in manufacturing technique that has speeded up production considerably. The foundation ring is double riveted throughout, and is welded from four pieces. The welding technique employed in Southern Railway works is as follows : The foundation ring is placed on a jig and levelled, and the side, back, throat and tubeplates are bolted in position. All the joints between these members are single V butt welds with the edges bevelled to give an included angle of 70 deg. with a 1/16-in. root face. Distance pieces 3/16-in. thick are placed between the plate edges, and the plates are tacked in position. After checking for alignment the assembly is placed in a manipulator, in order that all the welds may be performed in the downhand position. Stiffening bars are bolted to the plates to prevent distortion.

The first runs, using 8 gauge electrodes, are made by two welders, working simultaneously on the fire side of the joints between the side and throat and side and back plates respectively. These runs are then cleared of slag, chipped, ground and inspected. The second run on each joint is made by a 6 gauge electrode, and these sections are dealt with in a similar manner. The third and final run on the fire side follows, using a 6 gauge electrode; this run, which provides a reinforcement of 10 per cent. on the plate thickness at the centre of the weld, is thoroughly cleared of slag. To complete the joint, the surface of the first run on the water side is chipped out, ground and inspected, for the sealing run which is made with an 8 gauge electrode. This run is also thoroughly cleared of slag. It should be noted that defects in each run are cut out before proceeding with the next run. The tubeplate joint is dealt with similarly,

with the exception that only one welder is employed.

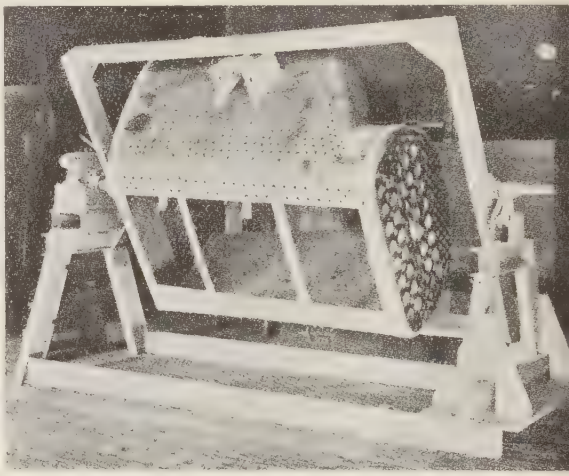
Next, the syphons are fitted and tack-welded with stiffening bars to the crown of the box to prevent distortion. The back-step method, performed by two welders, is used for the syphon joint at the crown. Although distance pieces 3/16 in. thick are used between the plates, contraction between them while welding is sufficient to squeeze the distance pieces to a thickness of 1/8 in., the design figure. Similar methods are used in constructing the outer firebox. The electrodes used are of the solid extruded type, using an arc voltage of 23-30, with a current of 150-160 amp. for an 8 gauge electrode, and 190 amp. for a 6 gauge. All pressings are stress-relieved before welding and all welding is examined by X-ray photographs. The boxes are not annealed after welding. The work of making thermic syphons was carried out by Beyer, Peacock and Co., Limited, at its Gorton works.

II. — Design of firebox and thermic syphons.

In the Merchant Navy class thermic syphons were used for the first time in Great Britain. Their manufacture involves the use of specially designed press blocks, and the method of flanging is adapted for cold working the plates, which are of special firebox quality. The syphon is made from a single sheet and an intricate contour has to be carefully developed. Operations on the plate are as follow : (1) forming the flanges for attachment to the crown-plate; (2) forming the bulges which support the brick arch; (3) folding the plate; (4) forming the cylindrical neck which connects the syphon to the throatplate, and the back and front flanges; (5) electrically welding the syphon on the back, front and neck; (6) fitting and riveting screwed stays in the flat sides of the syphon. On completion, the syphons are tested by hydraulic pressure to 50 per cent. above working pressure. All welds are examined by X-ray.

Experience with steel fireboxes.

In service, cracks occurred in the throatplate under the syphon necks and in the sideplates and doorplates, possibly owing to a combination of fierce heat and scale formation near the top



Manipulator for facilitating welding operations. By this means all welds are performed in the downhand position.

of the fire. Cracks in the throatplate are attributed in part to the straining of the plates when the openings for the syphon necks are pressed. Present practice is to cut out two openings in the throatplate and weld in special diaphragms for each syphon hole. Corrosion fatigue is also contributory cause. Many cracks are on the surface only and are easily welded *in situ* by selected specially trained welders. Fireboxes have now been in service for five years without plate renewal or any need for touching the welds. Repairs to syphons

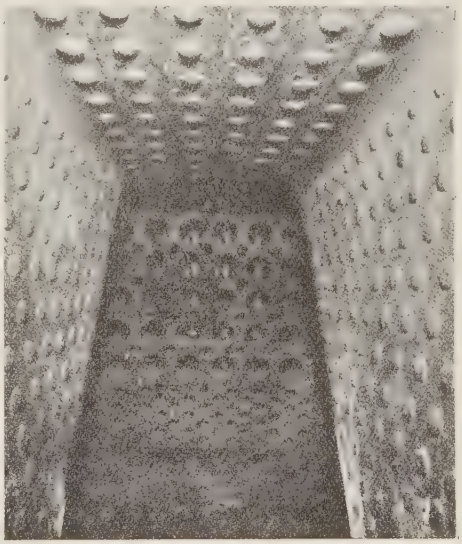
have only needed the welding and re-welding of a number of cracks, mostly surface cracks, and the rewelding of the ceiling weld at the neck in a few places. Except for recaulking some stays loosened through low water not a single stay in any syphon has required attention.

Cases of low-water level twice resulted in overheated crownplates. On engine No. 21C 4 all four fusible plugs acted and prevented serious damage. In this case, a hundred and fifty roof stays which were leaking were recaulked, in four slightly leaking flues, the ceiling welds were cut away and re-welded; and two top rows leaking slightly in the left syphon were recaulked. This relatively slight damage was due to the action of the fusible plugs and to the syphons, which, in addition to discharging water over the crownplate, reduced the area of plate exposed to the heat from the fire and, by being welded into the crown, assist the heat in the top plate to transmit itself to the water in the syphons.

Steel stays were used throughout. Flexible stays were used only round the syphon necks. In order to keep down their diameter so as to make them as flexible as possible, they are spaced at 3/4-in. centres, the diameter being 5/8 in. in the body and 7/8 in. over the screwed ends. The water legs were widened and the increased length was expected to reduce breakage. Fireboxes kept really clean have been practically free from leakage. There has been a number of broken stays in service, but these have not shown any grooving due to corrosion. The average number of stays renewed in the first 10 boilers after an average mileage of 141 000 per engine is 97.4. Pending investigation of the breakages, steel stays in the breaking zone are replaced as they fail by Monel metal stays.

Tubes.

Cold-drawn solid tubes to standard specifications are used. In the first boilers copper ferrules were used between the tubes and the tubeplate, following standard U.S.A. pratice, but with 1/32 in. ferrules. These have now been discarded as unnecessary. The tubes are expanded into the tubeplate and



Interior view of firebox after a case of low water level; view shows thermic syphons on each side.

beaded. A ceiling weld is made round each tube on the firebox tubeplate. Results obtained exceed all expectations. The tubes of the first 10 engines were renewed when they came into the shops for repairs after an average mileage of 130 000 miles. They were fit to run a further mileage had it not been thought desirable to replace during general repairs so as to ensure that they would require no attention before the engines came in for the next general repair. Fastening the tube to the tubeplate has justified itself, the tubes remaining

completely tight, again something not previously experienced.

In order to minimise the direct admission of cold air into the firebox and so protect the syphons and firebox plates from sudden changes of temperature, automatic steam-operated firedoors are fitted. The door is opened by a treadle which, when depressed by the fireman's foot, admits steam to the operating cylinder. The door remains open until steam is cut off by releasing the treadle. In this way the door can be opened and closed almost automatically for each shovel of coal fired. The arrangement was adapted from American practice and is excellent in operation, providing additional protection against any steam blow in the firebox.

The fabricated smokebox, when contrasted with the ordinary circular smokebox to which practice has been wedded, strikingly demonstrates the freedom in design obtainable by fabrication. An interesting feature is the use of corrugated pipes. The first engines, when built, had plain pipes 7 in. in diameter. These pipes were very rigid and the cylinder steam inlet flanges cracked and even broke through expansion stresses, hence their replacement by corrugated pipes. The two steampipes from the header are 7 in. in diameter and are continued down to the steam inlets of the outer cylinders at the same diameter. The middle cylinder is fed by two 6-in. pipes branched off the outer 7-in. pipes, each feeding one end. The flexibility of these pipes is suprising and should ensure steamtight joints over a long period. Since they were fitted no further trouble at the flanges has occurred.

Blastpipe and cylinders.

In the blastpipe, exhaust steam discharges through five nozzles of 2 5/8 in. diameter, passing to the atmosphere through a single chimney 2 ft. 1 in. at the choke. The nozzles discharge the exhaust steam in five cones, thereby increasing the area of contact between the steam and the combustion gases. The blower is placed round the nozzles and the steam from the large and small ejectors discharges into the cavity, thereby preventing a vacuum therein, which might draw in char from the smokebox.

Three separate cylinders are used as being more readily cast in the foundry and more convenient to machine. They are not in line, the inner cylinder being behind the outer cylinders and higher in the frames. All three cylinders drive the intermediate coupled axle. In the outside cylinders the incoming steam enters the casting at the top flange leading to the cored pipe feeding the steam-chests at each end, the total volume of this pipe and of the two end steamchests is 2.6 cu. ft., or 100 per cent. on the cylinder volume at the full cut-off of 70 per cent. The port area is 36.8 sq. in., opening to an area of 254.5 sq. ft. through the cylinder barrel. The clearance volume is 9.8 per cent.

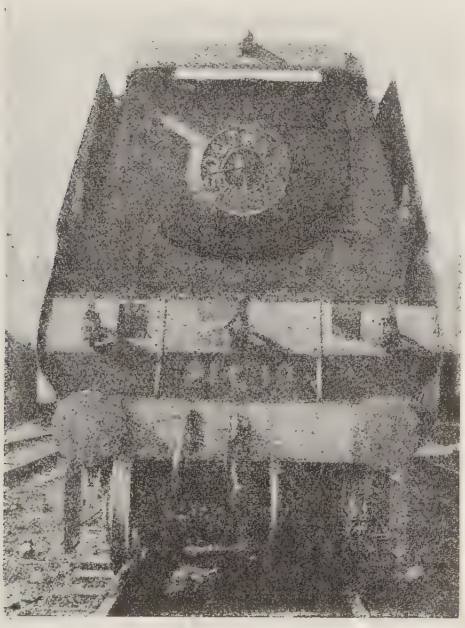
The exhaust port through the valve is 40.7 sq. in. in area and discharges directly into the valve cavity between the two valve heads. It passes through the exhaust pipe flange in the case of the outside cylinders, to be taken by a fabricated external exhaust pipe to the centre casting, where the three exhausts join under the common blastpipe. The cylinder castings have been simplified by this arrangement. Attention is called to the symmetrical arrangement of the cylinder and valve chest and the very direct passages.

III. — Details of radial valve gear.

Since early days the steam locomotive has remained unchanged as regards the lubrication of its moving parts. With the building of the Southern Pacific, the time had come to enclose as much of the motion as possible so that it could

be lubricated continuously by flood lubrication, instead of by the driver with his oil feeder. The parts may be less accessible if enclosed, but if the results desired, namely, no attention between general repairs, reduced wear, and freedom from heating, were achieved, this would not matter.

The problem is complicated by the relative movement of the frame to the crank axle. With the engine in question, not only was it decided to enclose the three sets of valve motion, but also the middle connecting rod, crosshead, slidebar and crankpin. Moreover, the three sets of valve gear had to be located between the frames. This meant that the inside piston rod and the three valve guides had to be taken out through the leading end of the sump. Flood lubrication was adopted as being simpler when oscillatory movements were involved. Two reversible gear pumps draw oil from the sump and force it through distributing pipes from which it is discharged over the moving parts. As the middle big-end tends to throw oil off during the upper half-revolution, it is fitted with a tundish which collects the oil during the lower half-revolution, and retains it during the upper. The forked type of big-end is used, as with this design the brasses are well supported and the oil ways are more conveniently arranged. The oil is filtered before it is distributed to the metered delivery pipes, and is drawn through a sieve by the pumps. The sump holds 40 gall., and the pumps, chain-driven from the valve crankshaft, deliver oil at a pressure of 20 lb. per sq. in.



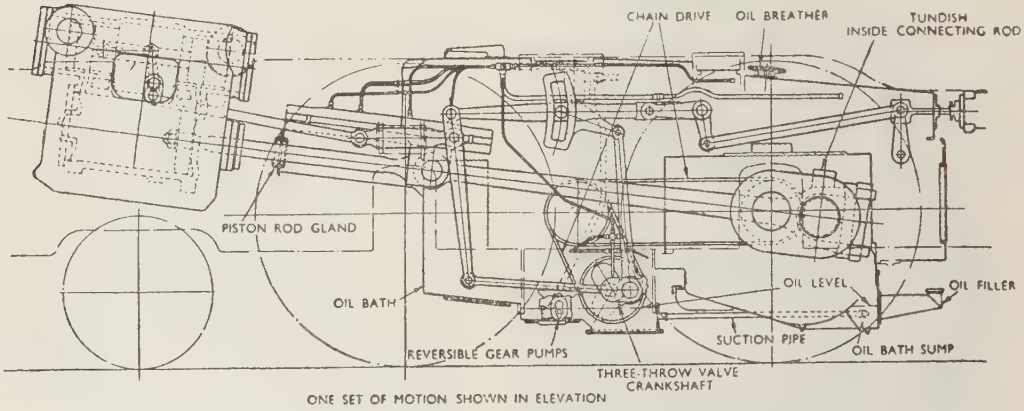
Front end arrangement of locomotive No. 21 C 12, showing the airscoop finally standardised.

At first, trouble occured through the pumps becoming choked with such things as fluff from cleaning cloths, and there was considerable oil leakage, but this loss has now been reduced and consumption is now reasonable. It has been found that the faces of the detachable parts of the sump have to be very rigid, so that the joint is not distorted when tightened. Finality has not, of course, been reached, but definite progress has been made towards the ideal of an automatically lubricated locomotive. As it is, the number of points to be oiled by feeder has been reduced from 92 to 31. Only two cases of overheated middle big-ends have occured in 1 400 000 miles. To avoid undue complication, the axleboxes were not included in the pump lubrication system.

The special conditions were such that no existing valve motion could be accommodated satisfactorily in the very restricted space available. Moreover, it was desirable to keep down the unsprung weight of the driving crank axle. The new valve gear used on the Southern Pacifics was accordingly invented, each piston valve being operated by a separate set of motion. The three

sets of gear are operated by a three-throw secondary crankshaft, each throw of which oscillates its quadrant link by a vertical connecting rod pinned to an arm extended backwards from the link. At the same time it reciprocates the foot of the combination lever by a horizontal link pinned to the big-end of the vertical connecting rod. The quadrant link operates the upper end of the combination lever in the usual manner.

The combined motion is conveyed through a plunger working in a guide by the valve rods to the valve-operating rocken shaft. The three-throw crankshaft has to be revolved in phase with the crank axle, and, though a gear drive was considered, it was abandoned in favour of the silent rocker chain drive shown in the drawing. Provision has been made for the frame to rise two inches and fall 1 1/2 in. relatively to the crank axle, and for this axle to move sideways as much as a quarter of an inch from its mid-position. By locating a layshaft four feet from the crankshaft centre, the maximum rise of the frame meant a lengthening of the hypotenuse by 0.04 in., a negligible amount in a chain 11.8 ft. long, consisting of 118 links. The layshaft in turn drives the three-throw crankshaft by a second chain. As the chain wheels are equal in diameter, the three-throw crankshaft is driven truly in phase with the crank axle.



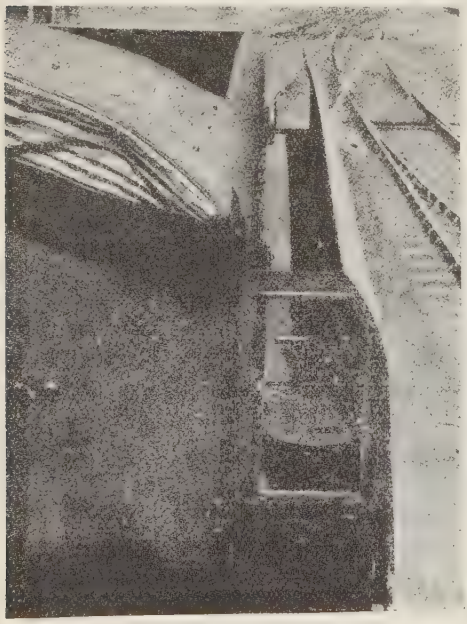
Longitudinal section through enclosed inside motion of Bulleid Merchant Navy class Pacific locomotive, Southern Railway.

Chain drive.

The power required to overcome the frictional resistance of an 11 in. piston valve, not under steam pressure and cold, was found experimentally to be 3 h.p. at 300 r.p.m. As there was no data as to the behaviour of chains under locomotive conditions, nor as to the maximum load the chain might have to transmit, nor as to the effect of snatch, a chain 2 in. wide was fitted. This chain will transmit 75 h.p. at a chain speed of 130 ft. per min. The weight of the toothed wheel secured to the axle is 125 lb. and half the weight of the chain is 30 lb. , a total of 155 lb. Three eccentrics plus the portion of the eccentric rods carried by the axle would have weighed 1 281 lb., so that the new drive reduced the unsprung axle weight by 1 126 lb.

With higher pressures, piston valves with inside admission and outside

exhaust have been favoured, to reduce the pressure on the valve spindle packings. The arrangement interferes with a free exhaust and the gland trouble is not eliminated. In these engines, a new method of operating the piston valves has been introduced, each pair of valves being driven by a rocker in the exhaust cavity. No valve spindles are used, and so the glands are suppressed and with



Looking back along near side of a Merchant Navy class tender.

them the objections to outside admission. The rocker is arranged across the cylinder, and when uncoupled, the arm in the exhaust cavity drops clear to allow the piston valves to be withdrawn. Piston valves 11 in. in diameter have been provided, which, in conjunction with large steamchest liner port areas, give an improved steam distribution. The weight of one piston valve complete is 99 lb.

This arrangement of piston valves has given no trouble, and the wear of the rings is much less than usual. Trouble was experienced with the first engines in the early days through the breaking of the driven arm of the piston valve rocker shaft of the middle cylinders. The cause was difficult to trace. The middle cylinder as first made did not incorporate any balancing passage between the two steamchests. The front steamchests were fed by a 6-in. pipe from the 7-in. pipe to the left cylinder, and the back by a 6-in. pipe from the 7-in. pipe to the right cylinder. It was expected that the pressures would equalise through the header.

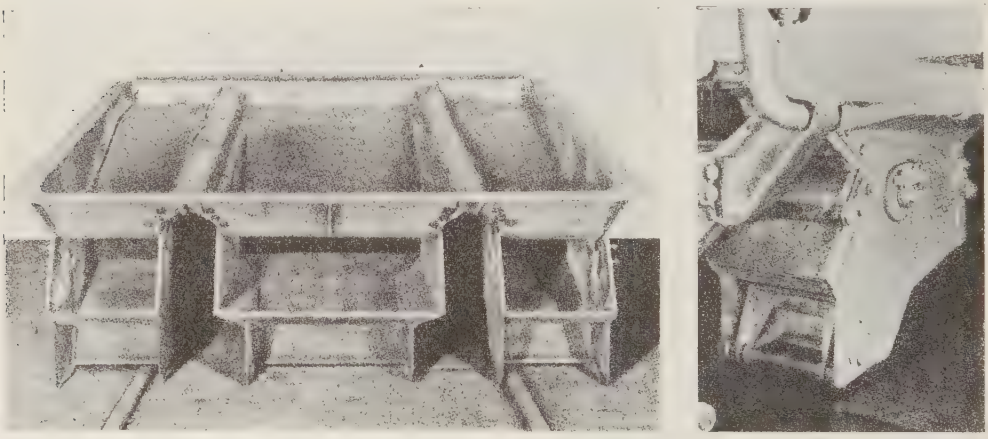
Dr. H. L. Guy suggested that it might be due to a sudden rise in pressure at the moment the valve uncovered the port to admit steam from the cylinder, resulting in a pressure difference in the two valves. An indicator diagram taken from the forward steamchest showed that the steam pressure was not steady, but varied continuously, though without any violent differences. It was argued that if the variations in the two steamchests did not coincide in point of time, there would be a difference in load on the two piston valve heads, and this difference, if large, would throw a heavy load on the driven crank. An external balancing pipe was fitted and no further trouble was experienced. The middle cylinders now incorporate two balancing passages, each 12.6 sq. in. in cross-sectioned area, cast in the cylinder block connecting the two steamchests.

The gear is reversed by steam. Objections to steam reversing gear expressed in the past were found to be due to the steam-operated gear not remaining set. Large oil passages are provided from the filling plug to the ends of the hydraulic cylinder, which constitutes the damping and locking device. Creeping was due to the hydraulic cylinder not being completely full of oil. This was traced to air bubbles trapped when filling, giving a false indication that the

cylinder was full, and since attention has been given to the filling pipes and passages to prevent air being entrapped, the cylinders can be filled right up. The gear will now remain in the position at which the driver sets it.

The main frames are of 1 1/8 in. plate; the greatest depth is 3 ft. 11 1/2 in. The large radii of the hornsheets above the boxes reduce the concentration of stress at the corners. No holes were drilled here, as it is the place where cracks usually develop, and wedges are holding-down bracket, additional cross-braces carrying the links and the reversing weighbar shaft.

In view of the wide use of welding, it may be asked why cast-steel frame stretchers were used. The reason was that up to the time the orders were placed, steel castings were readily obtainable, were thoroughly reliable, and could be expected to be cast to close limits. Moreover, welders were not available in sufficient numbers. The castings as delivered were heavy, and



The wide ashpan of the Merchant Navy class, Southern Railway and (right) ashpan hopper from the side.

not fitted. In addition to the usual hornstays, cross-stretchers—in front of the leading coupled wheels, between the leading and driving, and between the driving and trailing coupled wheels—have been arranged to reinforce the hornsheets as well. The forward stay provides the support for the main brakeshaft. The stay between the leading and driving coupled wheels also supports the three-throw crankshaft and the layshaft of the chain drive. The top cross-stay over the leading coupled axle carries the middle cylinder slidebar, three plunger guides and the boiler front

much work had to be done to lighten them. This drew attention to the advantages of fabrication by welding where suitable in the construction of the main frames. In the similar, smaller West Country class, all stretchers are fabricated, pressings being incorporated in them where possible to reduce the amount of welding.

B. F. B. wheels.

The most obvious departure from traditional practice is in the wheel centres used throughout these engines

and tenders. The usual locomotive wheel consists of a cast-steel spoked centre on which is shrunk a rolled steel tyre, and it has undergone little alteration since the earliest days. When the rims of spoked wheels in the shops for retyring are examined, flexing between the spokes is revealed by the condition of the rim and the inside of the tyre. The stresses set up in a rim when a tyre is shrunk on were investigated by polarised light on celluloid models in the laboratory at Ashford, and showed great variation from spoke to spoke. A locomotive wheel has not only to support the vertical load, but has to have considerable lateral strength to support the heavy thrust of the flange against the rail when taking curves. Lightness, too, is important to keep down the kinetic energy and unsprung weight.

Equalising rim stresses.

Eventually, with the collaboration of Thomas Firth and John Brown, Limited, the wheel known as the B. F. B. type was evolved. Under polarised light the models showed that the stresses in the rim inside the tyre had been equalised. The construction of the centre involves a corrugated plate or web, and suitable bridge pieces are introduced to support the tyre opposite each corrugation. The lightening of the wheel hub is noteworthy. These driving wheels are very strong laterally, while at the same time they are 10 per cent. lighter than the spoke type. The drive through the tyre depends entirely on the grip of the tyre on the centre. With the use of the Gibson ring, the lip on the inside of the tyre is closed over the loose ring by rolling it down cold. The ring is not a fastening; it is a retaining ring, and as such is a precaution intended to prevent the tyre leaving the centre should the tyre break. Apart from the drawback of having to roll the rim over the loose ring, a decidedly brutal proceeding, the section of the tyre is not good from a rolling mill point of view owing to the large amount of metal on the inside bore of the tyre on cross corners to the protecting flange. Instead of the Gibson fastening, therefore, a simpler arrangement was finally adopted, with the wheel centre recessed into the tyre without the ring. In this, the area of contact between rim and tyre is increased.

The opportunity was also taken to introduce a high-tensile alloy steel tyre in order to obtain maximum wearing qualities. The steel used is a nickel-molybdenum-chromium steel having an ultimate tensile strength of 63-69 tons per sq. in. with an elongation of 8-10 per cent. on two inches. The tempering temperature is 600 deg. F. and the tyres have to be heated to 450 deg. F. to expand them sufficiently for the projecting lip on the inside of the tyre to pass over the driving wheel rims. In view of the importance of heating these special tyres no more than was essential, but as uniformly as possible so as not to affect their temper, the method of heating hitherto in use in the workshops was reviewed, and it was found that the tyres were not, in fact, heated uniformly all round. The method of heating was therefore altered. Instead of holding the tyre stationary inside the heating shoes, it was placed on a face plate continuously revolved through gearing by an electric motor inside the stationary gasfired heating shoes. The heating is timed to prevent the temperature being raised too quickly, and uniform heating is now ensured. Special care is taken in measuring the centre diameter and tyre bore to prevent any excess over the shrinkage allowance.

These engines are fitted with the steam brake (vacuum on train). The wheels are fitted with clasp brakes, thereby obviating the thrust against the horns set up when single blocks are used. The brake block area in contact

with the tyres is increased, which improves the dissipation of heat when braking, and the blocks require less frequent changing.

On the Merchant Navy and West Country classes the lagging casing is carried by the main frames, instead of by the boiler as in orthodox practice. A very light welded frame of cold rolled sections has been used, and the outer casing made of 20-gauge plate. The cab is constructed on the same lines and the usual side platforms have been suppressed. This construction is at least 17 cwt. lighter than it would have been had the usual practice been followed. The exterior form of the casing was partly the result of the lightweight form of construction adopted. The channels, being cold-rolled, have to be rolled in circular curves. The form was also partly determined to ensure a clean exterior without projections, the advantages of which were obsiously attractive. The contour of the top of the casing is governed by the Belpaire corners of the firebox. The casing could have followed the shape of the boiler more closely, but this would have been more costly as each rib of the framework would have differed from the next, whereas now all are alike. An advantage of this form of construction is that the work can be done by sheet metal workers.

(To be continued).

[625. 113]

Curve realignment by the versine method,

by Prof Engineer Felice CORINI,
Director of the «Instituto di Comunicazioni» at the University of Genoa.

1. Introductory.

Under the action of passing traffic curved track is apt to become distorted and take up an alignment appreciably different from that originally planned. In view of modern high speeds, sometimes exceeding 200 km/h. (124 miles) on trunk routes, it is of prime importance that the centre line of the track should coincide exactly with the designed alignment. Curves of considerable minimum radius, high rails correctly superelevated, very accurate transitions (in both plan and elevation) between straight track and circular curves, — all these measures will be unavailing if the alignment is not continually restored; and curvature unsuitable for high speed is likely to develop.

Accordingly the railways have for many years used quick methods, involving the use of various appliances, for learning the condition of the track, and have applied well established rules for correcting it. One of the most convenient of these methods, and one particularly suitable for railroad conditions, is that known as the correction of the versines, which derives its name from the fact that it is based on the measurement of the versines on chords of equal length. This method has been the subject of numerous publications (see *Bibliography*). As a general rule, however, curve improvement on these lines involves processes of trial and error and therefore requires considerable time.

In the present article a combined graphical and analytical method is described, which enables the desired result to be obtained very rapidly. As the published matter describing the principles of the versine method is of a fragmentary nature, and scattered through various publications, it would seem to be a suitable occasion to set forth briefly but completely, the underlying theory of the method.

2. Versine diagrams of regular curves.

First case : Circular arc between two straight lines tangential to it.

Consider the straight line AT, the circular arc TT_1 of radius r and the straight line T_1 B, and let T, T_1 be the tangent points. Set out from T, in the direction of A, two segments, $\overline{T0}$, $\overline{00'}$ each equal to a (see fig. 1).

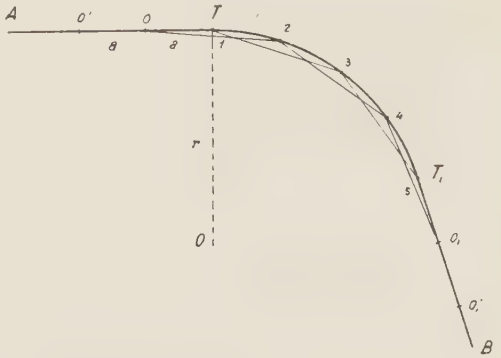


Fig. 1.

In the opposite direction mark out along the arc of the circle the points

2, 3, 4... so that the chords $\overline{1,2}$, $\overline{2,3}$, $\overline{3,4}$... are equal to a.

Now consider the segment $\overline{0'1}$ and the chords $\overline{0,2}$, $\overline{1,3}$, $\overline{2,4}$, $\overline{3,5}$, etc. *For the versine f_n at a point n on the centre-line the versine on the chord n-1, n-2, is taken.*

It is evident that as the centre line 0'1, coincides with the chord $\overline{0'1}$, the versine at point 0 is zero. We therefore have :

$$f_0 = 0 \quad . \quad . \quad . \quad . \quad (1)$$

The point 0, (distant a from the tangent point) from which the successive points on the curve are numbered is called the *point of approach*.

At the points 2, 3, 4..., the versine will have a constant value f_c.

The value of a should be chosen in relation to the radius of the curve, so that within the desired degree of approximation the following equations may be regarded as valid :

$$\overset{\frown}{n, n+1} = n, \overline{n+1} \sim a$$

$$\overline{n-1, n+1} = \sim 2\,(\overline{n, n+1}) = \sim 2a. \quad (2)$$

On this assumption we have :

$$f_c = \frac{a^2}{2r} \quad . \quad . \quad . \quad . \quad (3)$$

an approximate relation arrived at by regarding f_c as negligible in comparison with $2r$, that is to say by substituting $2r$ for $2r\text{-}f_c$.

The versine at point 1 is given by :

$$f_1 = \frac{1}{2} f_c \quad . \quad . \quad . \quad . \quad (4)$$

By applying equation (2) to the data of fig. 2 we have :

$$\overline{1,2'} = \sim \overline{1,2} = \overline{0,1} = a$$

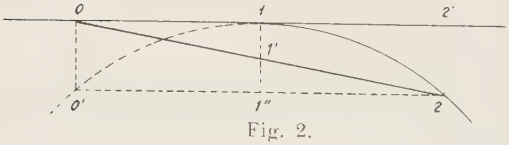


Fig. 2.

Since therefore :

$$\overline{0,1} = \frac{1}{2}\ \overline{0,2'}$$

it follows that :

$$\overline{1,1'} = \frac{1}{2}\ \overline{2,2}$$

whence :

$$f_a = f_1 = \frac{1}{2} f_c$$

Also, if we accept equations (2) and the expression (4), we may consider the versine at any generalised point between 0 and 2 as a linear function of the distance of the point from 0.

Calling this distance x, we have :

$$f_x = f_c \frac{x}{2a} \quad . \quad . \quad . \quad (5)$$

For $x = 0$, $x = a$, $x = 2a$, we have $f = 0$; $f_a = \frac{1}{2} f$; $f_{2a} = f_c$.

For $2a < x < \sigma$ (where σ represents the development of the arc, we have :

$$f = f_c \text{ (constant)}$$

For : $\sigma < x < \sigma + 2a$,

$$f_x = f_c \left(1 - \frac{x - \sigma}{2a}\right) \quad . \quad . \quad (6)$$

From (5) and (6) it follows that f is

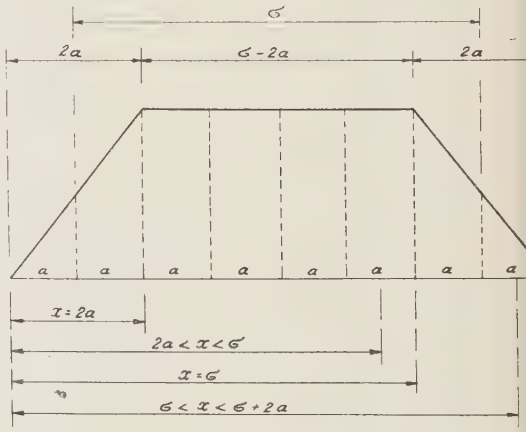


Fig. 3.

represented by an isoceles trapezium of height f_c, the oblique sides of which make an angle α with the horizontal, such that :

$$\text{tg } \alpha = \frac{f_c}{2a}.$$

Second case : Compound curve between two straight lines tangential to it.

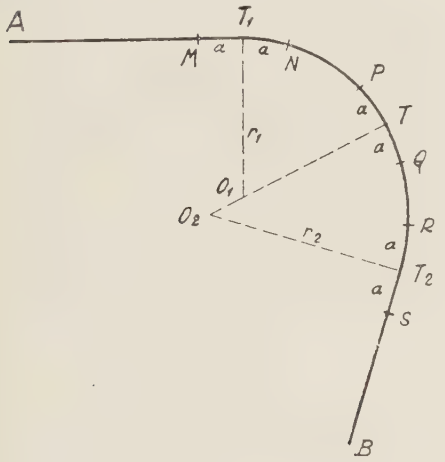


Fig. 4.

Imagine the centre line of the track to consist of the straight line AT_1, the circular arc T_1T of centre 0_1 and radius r_1, the circular arc TT_2 of centre 0_2 and radius r_2 and the straight line T_2B. From what has been said above it follows that the versine at any point on the arc T_1T separated from either tangent point by a distance along the curve greater than, or at least equal to a, the basic half-chord length, is given by :

$$f_{c_1} = \frac{a^2}{2r_1}.$$

At any point on the arc TT_2, separated from T or T_2 by arcs equal to, or greater than a, the versine is given by :

$$f_{c_2} = \frac{a^2}{2r_2}.$$

If $r_2 > r_1$, then :

$$f_{c_2} < f_{c_1}.$$

Between the points M and N, the versine varies from 0 to f_{c_1}; between R and S, it varies from f_{c_2} to 0; between P and Q, from f_{c_1} to f_{c_2}.

From the formulae (2) we may assume that the versine between f_{c_1} and f_{c_2} is a linear function of the distance along the arc, and that consequently the versine at point T is $\frac{f_1 + f_2}{2}$.

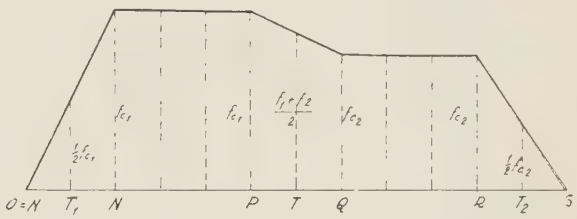


Fig. 5.

Thus the versine diagram is as shown in fig. 5.

Third case : Circular arc between two parabolic transition curves and two straight lines.

Consider the straight line AT_1, the cubic parabola T_1T, and the circular arc TB, followed by a similar sequence of arcs arranged symmetrically about the radius 0B. The equation to the curve T_1T with respect to the axes T_1x and T_1y is given by :

$$y = \frac{x^3}{6 \cdot r \cdot L} \quad \ldots \quad (7)$$

L being the length round the transition curve T_1T.

Again, from the formulae (2), we have, approximately :

$$T_1T_0 = T_1T = L.$$

The radius of curvature of (7) at some

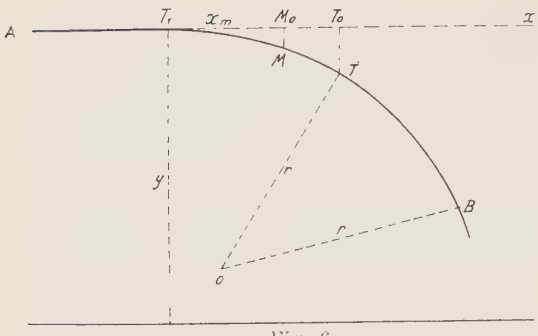


Fig. 6.

generalised point M, of abscissa x_m with respect to the origin T_1, is given by :

$$\rho_m = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}{\frac{d^2y}{dx^2}}$$

and, by regarding $\left(\frac{dy}{dx}\right)^2$ as negligible compared with unity, (which is justifiable when the axes are suitably chosen, and the length of the transition curve is small in relation to the minimum radius at T, we have :

$$\rho = \backsim \frac{1}{\frac{d^2y}{dx^2}} = \frac{r \cdot L}{x_m} \quad . \quad . \quad (8)$$

If we take as the versine at M (following the preliminary definition) the versine on the osculating circle of the cubic parabola, at M, we have :

$$f_m = \frac{a^2}{2\rho_m} = \frac{a^2}{2 \cdot r \cdot L} x_m$$

But :

$$\frac{a^2}{2r} = f_c,$$

the versine of intermediate points on the circular arc. Consequently we have :

$$f_m = f_c \frac{x_m}{L} \quad . \quad . \quad . \quad . \quad (9)$$

an expression which indicates that the versines on the transition curve are linear functions of the abscissae of the points, referred to the point of contact with the straight as origin.

The inclination of the line representing these versines will be given by :

$$\operatorname{tg} \beta = \frac{f_c}{L} \quad . \quad . \quad . \quad . \quad (10)$$

In fig. 7 we have :

A = original tangent point of the circular curve with the straight;

B = tangent point of the transition curve with the straight;

C = tangent point of the transition curve with the shifted circular curve;

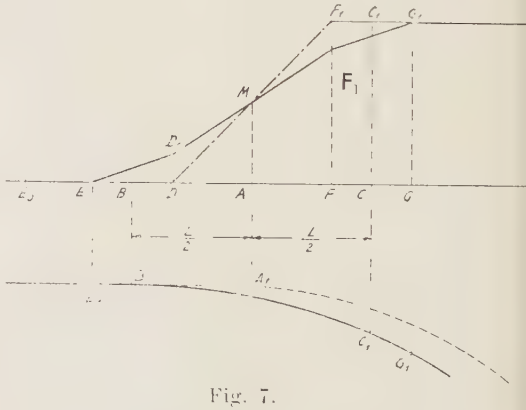


Fig. 7.

D = point of approach of the circular curve without transition;

E = point of approach of the transition curve (separated from A by an integral number of half-chord lengths a);

F = point situated at a distance a from A in the direction of the circle;

G = first point beyond the tangent point of the transition and circular curve, at an integral number of half-chord lengths a from A.

From equation (9), putting $x_m = \frac{L}{2}$ we obtain :

$$f_m = \frac{1}{2} f_e,$$

from which we deduce that the point M on the straight line DF_1, which represents the versines when there is no transition curve, is common to the straight line BC_1 which represents the versines of the transition curve, (the inclination of which is given by (10).) Thus, the straight line BC_1 is fully determined. If B and C_1 are separated from A by arcs $\frac{L}{2}$ which are not multiples of a, the diagram requires modification. For the versine diagram BC_1 we substitute the diagram $ED_1F'_1G_1$ obtained by projecting D and F on BC_1 and joining D_1 and F'_1 respectively to E and G_1.

The difference h between the versines corresponding to two successive points on the transition, separated by a, is plainly given by :

$$h = a \cdot \operatorname{tg} \beta$$

and from formula (10) :

$$h = f \cdot \frac{a}{L} \quad . \quad . \quad . \quad . \quad (11)$$

The modified diagram $ED_1F_1G_1$ represents the versines with a closer degree of approximation than the former one, but is still not exact.

The point representing zero versine is not E (see figs. 7 and 8), but E_0 preceding E by the distance a, just as the point at which the versine f_e is attained is not G_1 but G'_1, following G_1 at the distance a.

The versine at E is given by :

$$f_e = FH = \frac{1}{2} D_0D.$$

But from (7), D_0D is given by :

$$D_0D = \frac{(a-u)^3}{6 \cdot r \cdot L};$$

consequently :

$$f_e = \frac{1}{2} \frac{(a-u)^3}{6 \cdot r \cdot L}$$

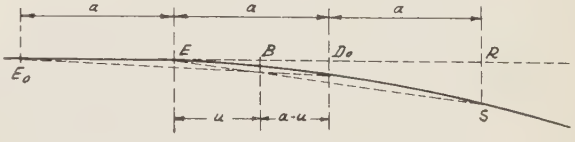


Fig. 8.

Knowing from (11) and (3) that :

$$h = f_e \frac{a}{L} = \frac{a^2}{2r} \frac{a}{L} = \frac{a^3}{2r \cdot L}$$

we have

$$2rL = \frac{a^3}{h}, \text{ and finally :}$$

$$f_e = \frac{h}{6} \frac{(a-u)^3}{a^3} \quad . \quad . \quad . \quad . \quad (12)$$

Similarly :

$$f_d = \frac{RS}{2} - D_0D$$

Whence :

$$f_d = \frac{h}{6} \frac{(2a-u)^3 - 2(a-u)^3}{a^3} \cdot (13)$$

If, taking a as the unit of measurement, we express u and f as fractions of a, these become :

$$\left.\begin{aligned} f_e &= \frac{h}{6}(1-u)^3 \\ f_d &= \frac{h}{6}\left[(2-u)^3 - 2(1-u)^3\right] \end{aligned}\right\} \quad (14)$$

For $u = 1$:

$$\left.\begin{aligned} f_e &= 0 \\ f_d &= \frac{h}{6} \end{aligned}\right\} \quad . \quad . \quad . \quad (15)$$

Likewise we obtain for F and G the formulae :

$$\left.\begin{aligned} f_1 &= f_c - \frac{h}{6}\left[(1+v)^3 - 2v^3 \right] \\ f_0 &= f_c - \frac{h}{6} v^3 \end{aligned}\right\} \quad (16)$$

Where v = CG.

For $v = 1$, $f_1 = f_c$, $f_0 = f_c - \frac{h}{6}$.

Let us denote the versine at point E by f_0, the versine at point D by f_1, the versines at successive distances of a by f_2, f_3..., and finally the versine at F by f_p and the versine at G by f_{p+1}.

To determine f_2, we apply formula (9), putting $x_m = 2a - u$, and obtain :

$$f_2 = \frac{f_c}{L}(2a - u)$$

and for $a = 1$:

$$f_2 = \frac{f_c}{L}(2 - u)$$

From (11) and in the case of $a = 1$:

$$\frac{f_c}{L} = h;$$

Whence :

$$f_2 = h\ (2 - u) \quad . \quad . \quad . \quad (17)$$

Assuming that beyond point 2 the constant increment h of the versines is given exactly by (11), and making use of formulae (14) and (17) we obtain the following results :

$$\left.\begin{aligned} f_0 &= \frac{h}{6}(1-u)^3 \\ f_1 &= \frac{h}{6}\left[(2-u)^3 - 2(1-u)^3 \right] \\ f_2 &= h\,(2-u) \\ f_3 &= h\,(3-u) \\ &\cdots\cdots \\ f_{p-1} &= h\,[(p-1)-u], \\ f_p &= f_c - \frac{h}{6}\left[(1+v)^3 - 2v^3 \right], \\ f_{p+1} &= f_c - \frac{h}{6} v^3 \end{aligned}\right\} \quad (18)$$

For $u = 1$, and $v = 0$, the formulae (18) become :

$$\left.\begin{aligned} f_0 &= 0 \\ f_1 &= \frac{h}{6} \\ f_2 &= h \\ f_3 &= 2h \\ &\cdots\cdots \\ f_{p-1} &= (p-2)\,h \\ f_p &= (p-1)\,h - \frac{h}{6} = f_c - \frac{h}{6} \\ f_{p+1} &= f_c \end{aligned}\right\} \quad (19)$$

The formulae thus derived determine completely the versine-diagram for the three typical cases examined, and also a fourth case consisting of a combination of the second and third (a compound curve between two transition curves and two straight lines), provided formulae (2) and (3) are valid. These conditions may be stated as follows :

a) The versines are negligible compared with the radii.

b) The differences between lengths round the arcs and chord-lengths are negligible.

c) The radii at the extremities of each chord may be regarded as parallel.

For radii commonly employed on standard gauge trunk routes; that is, of more than 300 m. (984 ft. 3 in) these conditions are satisfied with chords of 20 m. (65 ft. 7 3/8 in), that is to say with values of $a = 10$ m. (32 ft. 9 3/4 in).

For smaller radii it is preferable to make $a < 10$ m.

3. Versine diagrams of uncorrected curves.

Let us now consider a practical case. Commencing from the straight we mark off, along the face of one of the rails, points separated by a and measure the respective versines on the chords 0,2; 1,3;

2,4, etc. Having fixed a pair of axes at right angles, we set off, as abscissae, a succession of points at distances a, $2a$, $3a$, $4a$..., from 0; with the respective versines as ordinates.

By so doing we obtain an irregular diagram of the type seen in fig. 9.

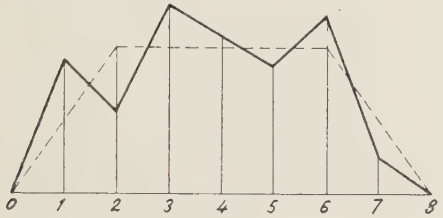


Fig. 9.

It follows, from what has been said above, that the correction of the alignment must consist of imparting to the various points of the track, displacements which will result in this irregular versine diagram being transformed into a regular diagram of one of the types reproduced above. If, for example, it is desired to achieve a circular curve with transitions, a versine diagram of the type seen in fig. 7 must be aimed at.

4. Determination of the displacements, and of the relations between the elements of the two curves.

Let us denote the tangent points between the curve and the straight lines by 1 and $n-1$ and the respective points of approach by 0 and n.

Let us imagine that we wish to carry out the improvement in such a way that the positions of the points 0, 1, $n-1$, n, are unchanged. In such a case any displacement we give to the points on the curve must not effect those parts of the curve which lie outside the section $\overline{0n}$. Out of these restrictions arise certain relations between the elements of the two curves, which must be satisfied in every case.

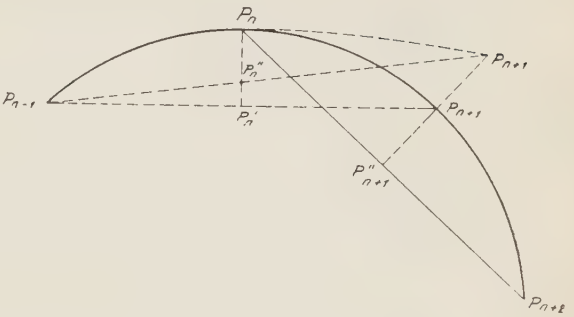


Fig. 10.

Let P_{n-1} P_n, P_{n+1} be three points, distance a apart, on the surveyed curve. The versine recorded in respect of the point P_n will be P_n $P'_n = f_n$.

The point P_{n+1} undergoes a displacement of S_{n+1} in a direction at right angles to the curve.

Displacements towards the exterior of the curve are considered as positive and those towards the interior as negative.

The other points do not undergo displacement.

The versine of point P_n in relation to the corrected curve (that obtained after the displacement) will be P_n $P''_n = F_n$.

In accordance with the hypotheses formulated above we may assume P''_n P'_n and P'_{n+1} P_{n+1} to be parallel, and that P''_n P'_n is therefore equal to $\frac{S_{n+1}}{2}$.

Whence the following relations (in which f represents the versines in respect of the curve as surveyed and F corresponds to the corrected curve) become apparent:

$$\left.\begin{aligned} F_{n+1} &= f_{n+1} + S_{n+1} \\ F_n &= f_n = \frac{S_{n+1}}{2} \end{aligned}\right\} \quad . \quad . \quad (20)$$

If the points P_n and P_{n+2} are displaced at the same time as the point P''_{n+1} we have :

$$F_{n+1} = f_{n+1} + S_{n+1} - \frac{S_n + S_{n+2}}{2} \qquad (21)$$

Giving to n the values 0, 1, 2, 3... we obtain the formulae :

$$\left.\begin{aligned} F_1 &= f_1 + S_1 - \frac{S_0 + S_2}{2} \\ F_2 &= f_2 + S_2 - \frac{S_1 + S_2}{2} \\ F_3 &= f_3 + S_3 - \frac{S_2 + S_3}{2} \\ &\cdots\cdots\cdots \end{aligned}\right\} \quad \ldots \quad (22)$$

Again, in accordance with the hypotheses formulated above, we have :

$S_0 = S_1 = 0$ and the formulae (21) then become :

$$\left.\begin{aligned} F_1 &= f_1 - \frac{S_2}{2} \\ F_2 &= f_2 + S_2 - \frac{S_3}{2} \\ F_3 &= f_3 + S_3 - \frac{S_3}{2} - \frac{S_4}{2} \\ &\cdots\cdots\cdots \end{aligned}\right\} \quad \ldots \quad (23)$$

Putting $f_n - F_n = d_n$ the relations set forth below may be derived from the formulae (23) :

$$\left.\begin{aligned} \frac{S_2}{2} &= d_1 \\ \frac{S_3}{2} &= d_2 + 2\,d_1 \\ \frac{S_4}{2} &= d_3 + 2\,d_2 + 3\,d_1 \\ &\cdots\cdots\cdots \\ \frac{S_n}{2} &= (n-1)\,d_1 + (n-2)\,d_2 + \ldots \\ &\quad + 3d_{n-3} + 2d_{n-2} + d_{n-1} \\ \frac{S_{n+1}}{2} &= nd_1 + (n-1)d_2 + \ldots + 3d_{n-2} \\ &\quad + 2d_{n-1} + d_n \end{aligned}\right\} \quad (24)$$

But we have also accepted the conditions $S_n = 0$ and $S_{n+1} = 0$; consequently the two latter equations of (24) give rise to the following :

$$\left.\begin{aligned} (n-1)\,d_1 + (n-2)\,d_2 + \ldots + d_{n-1} &= 0 \\ nd_1 + (n-1)\,d_2 + \ldots + 2\,d_{n-1} + d &= 0 \end{aligned}\right\} \quad (25)$$

ore $$\sum_{p=1}^{p=n} (n+1-p)\,d_p = 0 \quad . \quad (26)$$

By expanding the first equation of (25) and combining it with the second, we obtain :

$$d_1 + d_2 + \ldots\ldots + d_{n1} + d_n = 0$$

whence $$\sum_{p=1}^{p=n} d_p = 0 \quad . \quad . \quad . \quad . \quad (27)$$

We may give practical significance to the expressions (27) and (26) by considering the area of the versine diagram. This diagram consists of two end triangles and a series of trapezia, the total area of which is given by :

$$A = \frac{1}{2}\,a\,f_1 + a\frac{f_1 + f_2}{2} + \ldots + a\,\frac{f_{n-1} + f_n}{2}$$

whence, for $a = 1$:

$$A = \sum_{p=1}^{p=n} f_p \quad . \quad . \quad . \quad . \quad (28)$$

The relation (27) may be written as follows :

$$\sum_{1}^{n} f_p - \sum_{1}^{n} F_p = 0$$

or again : $$\sum_{1}^{n} f_p = \sum_{1}^{n} F_p \quad . \quad . \quad . \quad (29)$$

and from (28) :

$$A = A'$$

A *being the area of the diagram of versines as recorded and* A′ *the area of the diagram of versines as corrected.*

Given that f_p represents the elemental area enclosed by the ordinates f_n and the lengths $a = 1$; and that $(n+1-p) = (n+1-p)\,a$, when $a = 1$, represents the distance of the p *th* ordinate from the last ordinate of the diagram [the $(n+1)$ ordinate], equation (26) which may be re-written as follows :

$$\sum_{1}^{n} (n+1-p)\,f_p = \sum_{1}^{n} (n+1\ p)F_p$$

shows us that *the moment of the « recor-*

ded » versine diagram about the end ordinate, is equal to the moment of the corrected versine diagram about the same ordinate, which implies that the centres of gravity of the two areas are coincident.

From this conclusion we may further deduce that the moments of the two areas about any ordinate whatever and not only about the end ordinate, must be the same, which allows of a new interpretation of the expression (26) by considering the moments of the areas about the first ordinate.

To summarise, the following are the equations which solve the problem of curve realignment :

$$\left.\begin{aligned} &\sum_{1}^{n} d_p = 0 \\ &\sum_{1}^{n} p\, d_p = 0 \\ &\frac{S^p}{2} = \sum_{m=1}^{m=p} m\, d_{p-m} \\ &S_0 = S_1 = S_n = S_{n+1} = 0 \end{aligned}\right\} \qquad (30)$$

The first of these equations signifies that the areas of the primitive-and corrected versine diagrams must be equivalent; the second, that the centres of gravity of the areas must coincide; the third, that the half-throw of the p th point is equal to the summation of the moments of the differences d about the ordinate of the point in question.

5. Procedure in correcting a curve.

Having plotted the diagram of the recorded versines, we attempt, if possible, to effect the improvement by means of a single circular arc and two transition curves, or if necessary, by the adoption of a compound curve. Let us suppose that the general appearance of the diagram suggests the use of a single circular curve. If the original curve is without transitions, we draft by eye a give-and-take isoceles trapezium of height F_c. Through the mid-points M_1, M' of the oblique sides, we draw two straight lines inclined at an angle β, such that :

$$\operatorname{tg} \beta = \frac{F_c}{L}$$

We thus obtain the tangent points B and C of the transition curve with the straight line and the circular arc, locate the points of approach :

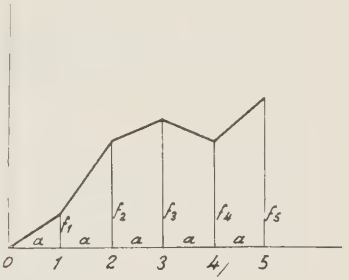


Fig. 11.

E and G, and adjust the versine diagram accordingly by means of the segments ED_1, $F'G$, etc.

If the original curve is already provided with transitions we plot the give-and-take isoceles trapezium directly with the oblique sides inclined at the angle β. The ordinates of the diagram thus obtained represent the tentative versines of the corrected curve.

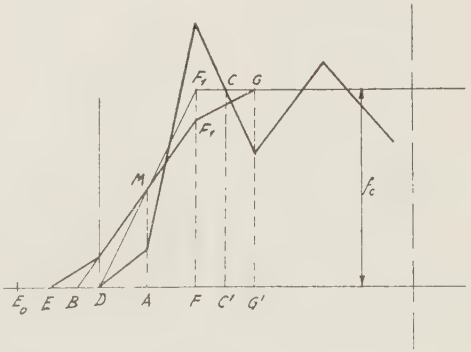


Fig. 12.

We must first verify that the first equation of (30) is satisfied, or rather that the sum of the recorded versines is equal to the sum of the provisionally corrected versines. If this condition is not fulfilled, we introduce suitably chosen displacements until the first equation of (30) is satisfied. The versines F may be scaled from the drawing, or preferably, calculated, F_c being the average of the values of f_c .

The versines for the transition may be calculated by means of the formula (18), which will enable the values of $u = EB$ and $v = CG$ to be fixed.

This done, we must verify the second equation of (30) is satisfied, that is to say that the centres of gravity of the areas of the two versine diagrams are coincident. We do this by verifying, either analytically or graphically, that the moments about the first or the last ordinate are equal. The graphical method involves the construction of two funicular polygons based on segments proportional to the elemental areas of the two diagrams and the establishment of equality between the lengths intercepted by the first and last sides on the last ordinate. If the moments are not found to be equal, the values of F_p will have to be adjusted.

To ascertain the effect of such corrections it is helpful to consider the third equation of (30), wherein a variation V_p in the difference d_p, caused by reducing F_p ($V_p > 0$) or increasing F_p ($V_p < 0$), results in a variation $(n - p)\ V_p$ of the value of the moment. In order to satisfy the second equation of (30), or to nullify or reduce for practical reasons the displacement of a point, it is convenient to introduce *groups of variations* to which we give the name « *correcting groups* ». The absolute value of a correcting group is the sum of the absolute values of the individual variations, and the moment of a group is the sum of the moments of the individual variations.

The displacements are determined by means of the third equation of (30).

In preparing versine diagrams we adopt a scale of 1/1000 for the lengths of the arcs, while the versines, by contrast, are plotted full size or multiples of full size. In the field the versines are measured to the nearest 1 mm. (3/64 in.) employing appropriate methods and precautions.

6. A direct graphical method for the improvement of curves.

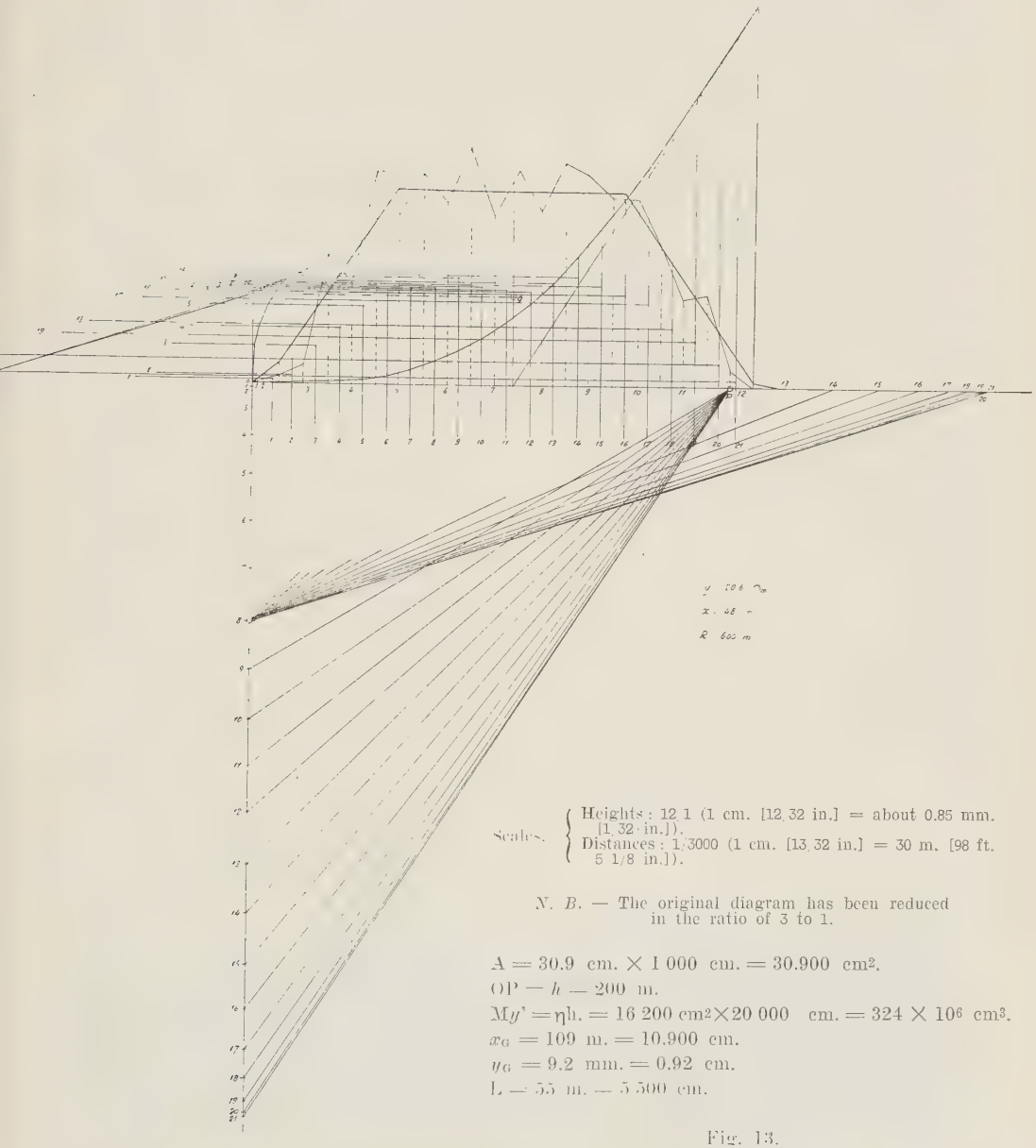
It is evident that the method described above may be very tedious when first attempts do not at once afford good results. It can be replaced by the following direct graphical method :

Having plotted the versine diagram to suitably chosen scales, we divide in into strips of width a (a being the distance between the points at which the versines were measured); at the centres of gravity of the various strips we construct segments proportional to the areas (see fig. 13).

The segments unite into a funicular polygon with a polar distance $p = h\ a$, The segment AB intercepted by the first and last sides of the funicular polygon on the last vertical, represents the moment of the area of the versines about that vertical.

The point of intersection R between the first and last sides of the funicular polygon determines the line of action of the resultant.

If, after having turned the segments 1, 2 . . . . 11, through 90° we construct from them a new funicular polygon, the



Scales. { Heights : 12.1 (1 cm. [12.32 in.] = about 0.85 mm. [1.32 in.]).
Distances : 1/3000 (1 cm. [13.32 in.] = 30 m. [98 ft. 5 1/8 in.]).

N. B. — The original diagram has been reduced in the ratio of 3 to 1.

$A = 30.9$ cm. $\times$ 1 000 cm. $= 30.900$ cm^2.
OP $= h = 200$ m.
$My' = \eta h. = 16\,200$ cm$^2 \times 20\,000$ cm. $= 324 \times 10^6$ cm^3.
$x_G = 109$ m. $= 10.900$ cm.
$y_G = 9.2$ mm. $= 0.92$ cm.
L $= 55$ m. $= 5\,500$ cm.

Fig. 13.

point of intersection of the first and last sides determines the line of action of the resultant.

The point of intersection G of the two resultants is the centre of gravity of the versine diagram.

Let us suppose that the form of the versine diagram is such as to allow of correction by means of a single circular arc and two transitions.

The length of transition being fixed as L, it remains to construct an isoceles trapezium of a given area A, represented by the segment $\overline{0,11}$ to the scale indicated on the diagram, with oblique sides, the projections of which on the base, are equal to L, and with centre of gravity G at distance GH from the base.

Let $2x$ be the shorter side of the trapezium and y the height. The longer side will be $2\ (x + L)$.

It is required that :

$$(2x + L)\ y = A \quad . \quad . \quad . \quad (1)$$

Moreover, on taking moments about the longer side of the two triangles and rectangle into which the trapezium may be resolved, we have :

$$A.\Delta = x\,y^2 + \frac{1}{3} L\,y^2 \quad . \quad . \quad (2)$$

These two equations contain the solution of the problem.

From equation (2) we obtain :

$$y^2 = \frac{3\,A.\,\Delta}{3\,x + L} \quad . \quad . \quad . \quad (3)$$

By substituting this value into equation (1), duly squared, we obtain :

$$3\ (2\,x + L)^2.\Delta = (3\,x + L)\,A$$

Whence :

$$12.\Delta x^2 + 12.L.\Delta - 3\,A)\,x + L$$
$$3\,L.\Delta - A) = 0 \quad . \quad . \quad . \quad (4)$$

By substituting in equation (3) the values of x obtained from this equation we obtain the corresponding values of y.

It is a simple matter to recognise which pair of values have practical significance.

Having designed the trapezium, the extremities of the oblique sides are corrected in accordance with the rules formulated in the previous section, and the points of approach are plotted.

By means of the diagram the alterations $d = f - F$ at every point are read off.

As a check we may plot the graph of d, construct the sum-curve and verify that the average ordinate is zero. We may also prove that the moment of this area about any vertical whatever is zero.

If the improvement calls for the use of two different curves, the instructions given for the present case may be easily extended.

Fig. 13 shows an actual example.

* * *

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[625. 232 (.42)]

L. M. S. R. new composite third class brake vehicles.

(The Railway Gazette.)

Modifications and improvements, which are the result of many months of research in workshops and on the track, will be seen in 225 new corridor third brakes vehicles under construction at the L.M.S.R. works at Derby. The coaches were designed by the late Mr. C. E. Fairburn, Chief Mechanical & Electrical Engineer of the L.M.S.R., and form part of the company's immediate constructional programme of 800 new coaches, 200 of which have passed into service since VE-Day.

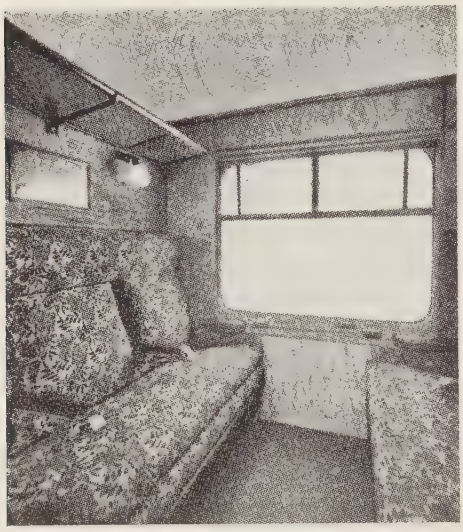
The new corridor third brakes are 57 ft. long and 9 ft. wide, and have four passenger compartments, one lavatory, and a luggage and guard's compartment. They are mounted on 4-wheeled bogies of all-welded standard L.M.S.R. construction, 9 ft. wheelbase with rolled-steel disc wheels having axles with 9 ft. × 4 5/8 in. dia. journals. Two pairs of steel helical springs are used for the bolster with laminated side bearing springs 5 ft. centres of eyes fitted with rubber auxiliary springs.

The underframe follows the standard L.M.S.R. design for 57 ft. long carriage stock and is fitted with shock-absorbing buffers, articulated drawgear, and screw couplings. The frame is built from standard rolled-steel sections, electrically-welded throughout, with a completely flush upper surface to receive the corrugated steel floor sheets which form the base for the floor. These sheets, No. 16 s.w.g. galvanised steel, are welded to the underframe members, and have cork slabs inlaid for the passenger compartments and corridor, with blown bitumen for the brake and luggage compartment.

The body structure consists of teak pillars bolted to pressed-steel sockets welded to the underframe solebar and the steel angle cant rails. The exterior of the bodyside has a flush finish, the panels, No. 16 s.w.g. steel, are carbon arc-welded into one complete unit extending the full length of the bodyside between the doors before being secured to the body framing. The body ends are built up with rolled-steel angle pillars and arch rails welded to the underframe members and cant rails, and covered on the outside by No. 16 s.w.g. steel panels.

Steel angle carlines welded to the cant rails carry the outer roof panels of

Side elevation of L.M.S.R. new composite third class brake vehicle. Note the unobstructed vision through corridor windows.



Interior of third-class 6-seat compartment, convertible to 8 seats with armrests raised.

No. 16 s.w.g. galvanised-steel sheets, the joints of which are arranged to coincide with the carlines. The method of connection and securing is by metallic arc welding.

The tare weight of the vehicle is 30 tons.

Seating and decoration.

Accommodation is provided by the four compartments for 24 passengers, six per compartment, three on each side. Hinged arm rests are fitted and these can be folded back flush into the seat backs, thus giving four seats each side or a total of 32 passengers a car when necessary.

Special attention has been paid to the contour and springing of the seat and seat back to obtain maximum comfort for the passengers. The seats are double sprung, with well-upholstered seat back and head rest. The seat, back, head rest, and side squabs are finished with moquettes to match the interior woodwork finish.

A variety of finishing timbers is being used for various portions of this order, namely, betula, makore, silky oak and bubingo, with framing timbers to match.

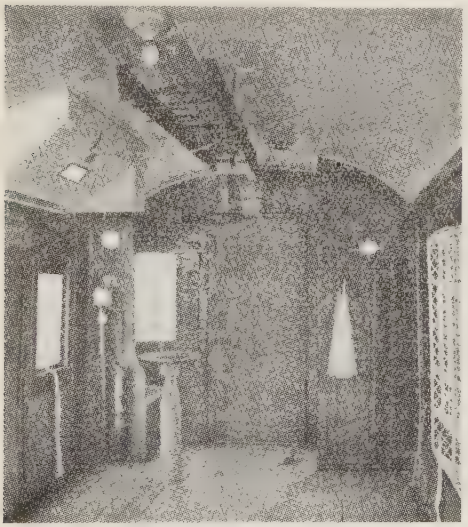
The interior is of a flush design, mouldings, and projections being reduced to a minimum. There is one mirror above each seat back and the metal fittings are finished in oxidised venetian bronze. The compartments and corridor are fitted with large observation windows having a low sill height, each of which is equipped with a double sliding extractor ventilator light.

Communication between the compartments and corridor is obtained by double sliding door to each compartment. These doors have large windows which provide uninterrupted vision from the compartment through the corridor body-

View along corridor showing the deep windows. Note the high degree of actinic light.

side window, which is directly opposite the doors; the corridor partition consists of laminated plywood panels.

The compartment slidings doors are fitted with cable controlled blinds which enable the latter to be adjusted to any height. Experiments recently have been made with regard to the exclusion of



Interior of guard's compartment and brake van equipment. Observe vertical steam heater next guard's seat.

draughts, as a result of which a prevention device has been fitted to the compartment sliding doors. Provision is made in each compartment for the use of a table; the tables are stored in the brake compartment when not in use. The cork floor in the compartments and corridor is covered with felt and brown linoleum.

The carriages are steam-heated; each compartment has two 3-ft. gilled heaters which are thermostatically controlled and are also fitted with a cut-off valve which can be operated by the passenger. Recessed heaters are installed in the corridor.

Several new features have been embodied to ensure a good supply of hot water together with easier maintenance of the fittings in the toilet.

The luggage and brake compartment contains upholstered seats for the guard with lockers, hand-brake wheel, vacuum-brake application valve, emergency tool equipment, and vertical steam heater adjacent to the guard's seat. Two pairs of double doors are fitted on each body-side of the brake compartment.

Electric lighting.

Electric lighting is provided by the company's standard „Wolverton" system. This is a single-battery equipment, the regulator of which combines all the necessary switchgear as a unit. Lighting is by means of 15-watt lamps, of which there are five in each compartment, one in a reflector fitting on the ceiling and four mounted on moulded plastic brackets over the seat backs. The brackets are fitted with opal-glass shades and carry a switch-lamp holder, giving individual control. Two brackets are fixed over the mirror in the toilet. All circuits are protected by non-interchangeable fuses of the cartridge type and each bracket carries an individual fuse combined with a plug. The coach is furnished with standard R.C.H. through-control, and a main controller in the brake compartment provides control of the whole train to which the vehicle is connected or, alternatively, of the individual coach only.

621. 87 (.44) & 625. 245 (.44) |

French National Railways 130 t. (128 tons) breakdown crane,*

by M. BRÉAU,

Chief Draughtsman, Chief Mechanical Engineer's Department, South-Western Section of the French National Railways.

(Revue Générale des Chemins de Fer.)

Introduction.

The difficulties encountered for many years past in lifting derailed rolling stock on account of the continual increase in the weight of carriage and wagon stock and locomotives, led the main French Companies to consider obtaining a more powerful crane than those so far used.

After a joint investigation by the departments of the Railway Companies concerned and taking into account the experience gained at certain difficult breakdowns, it was decided in 1932 to specify the following for the crane to be constructed :

130 t. (128 tons) at 6.25 m. (20 ft. 6 3/32 in.) radius,

60 t. (59 tons) at 10 m. (32 ft. 9 3/4 in.) radius.

The Cockerill Company's tender was preferred. This Company moreover owned a 125 t. (123 tons) travelling crane which had been in service at their Works for the past twenty years and which the Belgian Railways had used on various occasions.

The crane was therefore designed by the Cockerill Company and the construction shared between that firm and the Fives-Lille Company, the latter being responsible for the construction of the bogies, the main underframe and the equipment of the match wagons.

The actual conditions specified were as follows : the crane must be capable of lifting 130 t. (128 tons) at 6.250 m. (20 ft. 6 3/32 in.) radius and 90 t. (89 tons) at 9.550 m. (31 ft. 4 1/16 in.) radius with the jib facing down the centre line of the track; the distribution of the weight of the crane on the rails must eliminate all risks of dangerous deflections on bridges and very strict limits were laid down to this effect.

The crane was delivered at the end of 1938 and numerous reception trials were undertaken immediately.

General arrangement of the machine.

The stability of a powerful railway crane obviously cannot be obtained, under the worst conditions, by utilising solely the supporting base made up of the wheels and axles. The 130 t. crane is fitted with pivoting supporting arms which are closed whilst travelling and opened when lifting heavy loads. At

* Translation of the article by Mr. M. Bréau, published in the *Bulletin (French Edition)* of June 1940.

the time of such operations the ends of the arms are supported by packings on each side of the track (fig. 1).

The lifting at the minimum radius of 6.250 m. (20 ft. 6 3/32 in.) of loads having a width approximately equal to that of the gauge presumes that no detail of the crane is more than 4.700 m. (15 ft. 5 in.) from the rotating axis. It is, therefore, necessary to remove the bogie situated in the field of operation and even, in some cases, the two bogies. The crane has been equipped accordingly.

The crane can be moved under its own power; the bogies are driven through gearing through the pivot of the hoist motor.

The limiting of bending due to the weight of the crane to an acceptable figure is obtained by means of :

1. — A fairly light construction. The calculation of all the details was closely investigated and it led to the use of high tensible materials, especially for certain underframe details and mechanical parts;

2. — The removal of its counterweight when the crane is travelling by carrying it on a match wagon;

Fig. 1. — Crane supported on 8 jacks.

3. — The use of two 8-wheeled bogies of large wheel base, the total wheel base being 13.500 m. (44 ft. 3 11/16 in.) and that of each bogie 4.500 m. (14 ft. 9 3/16 in.).

The crane when travelling is usually worked between two special match wagons; one carrying the counterweight and additional coal bunker and water tank, and the other the jacks, etc., and a rest for the head of the jib when lowered to the maximum (fig. 2).

Fig. 2. — Crane ready for travelling in convoy.

Description of the stock.

1. *General characteristics.*

Speed of lifting 130 t. (128 tons) hook	2.25 m./mn. (7 ft. 4 19/32 in./m.)
Speed of lifting 25 t. (24 1/2 tons) hook	11.25 m./mn. (36 ft. 10 27/32 in./m.)
Speed of lifting hook used on single chain for 12.5 t. (12 1/3 tons)	22.50 m./mn. (73 ft. 9 13/16 in./m.)
Slewing speed with load of 130 t. 1 turn in	1 1/2 mn. (1 1/2 m.)
Speed of travel without load	20 m./mn. (65 ft. 7 3/8 in./m.)
Bore of cylinders	260 mm. (10 1/4 in.)
Piston stroke	260 mm. (10 1/4 in.)
Normal speed of engine	150 revs./mn.
Boiler pressure	14 Hpz. (203 lb. sq. in.)
Heating surface	35 sq. m. (376 2/3 sq. ft.)
Grate area	1.08 sq. m. (11 sq. ft.)
Capacity of the coal bunker carried on the crane	300 kgr. (6 cwts)
Capacity of the coal bunker carried on the match wagon	2 000 kgr. (2 tons)
Capacity of water tank carried on the crane	1 450 litres (319 gallons)
Capacity of water tank carried on match wagon	3 200 litres (704 gallons)
Total weight on the track :	
Ond the Crane axles	139 200 kgr. (137 tons)
On the axles of the counter weight wagon	62 170 kgr. (61 tons 4 cwts)
On the axles of the jib wagon	38 360 kgr. (37 tons 15 cwts)
Weight per axle	17 400 kgr. (17 tons 2 1/2 cwts)
Weight per metre run	8 410 kgr. (8 tons 5 1/2 cwts)

2. *Bogies.*

The bogie frame is of riveted construction with the exception of a special cast steel cross member carrying the gear drive.

The central beam receives the spherical centre bearing and slides. The lower portion of the bearing can be slid along the beam by means of powerful adjusting screws, in order to compensate for any transverse displacement of the underframe resulting, for example, from the track settling down.

The travelling gear (fig. 3) drives the two axles of the bogie through worm screw in an oil tight case and sliding gears. The gear is driven through an universal joint of the pattern used in rolling mills. A jack is provided so that the driving shaft can be taken down quickly. This latter operation has to be done when removing the bogies or lifting them clear of the field of operation. These operations are carried out after raising the crane by means of hydraulic jacks fitted under the main frame.

The headstocks carrying the drawgear can be easily taken down in order to remove the bogie and to get close to the loads to be lifted.

The axleguards of the oilboxes have a small screw jack to carry the weight of the frame on the boxes whilst loads are being lifted in order to avoid the overloading of the suspension springs. In the same way the screw jacks arranged between the underframe and the bogies allow the play of the slides to be taken up during the hoist.

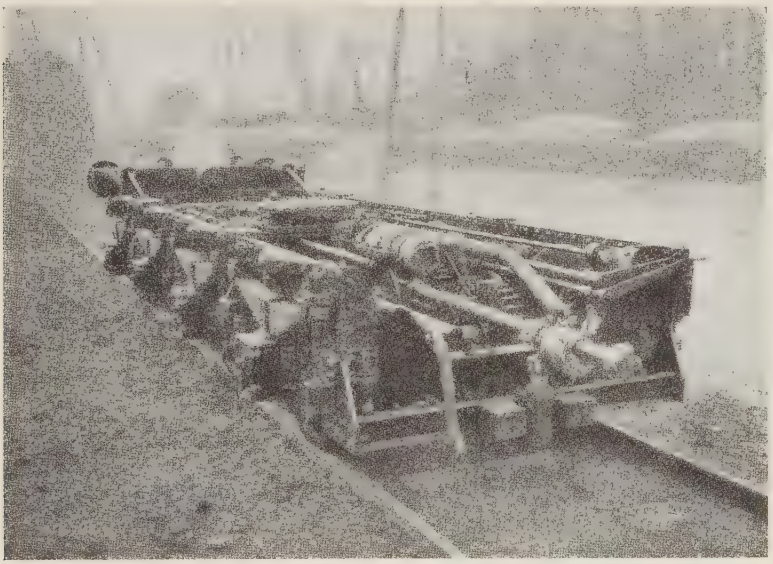


Fig. 3. — Bogie withdrawn showing the travelling gear and clover shaped shaft.

Each bogie is equipped with Westinghouse brake working on 8 blocks with L. U. VI « plaine-montagne » triple valves, and in addition a hand brake.

3. *Underframe.*

The underframe is composed of a central frame made up of plates and sec-

tions and end crossbars of special manganese steel from the Cockerill foundries.

The whole weighs 21 t. (20 tons 13 1/2 cwts), 10 t. (9 tons 16 3/4 cwts) of which is of cast steel. Riveting has been used with the exception of some flanges which are welded.

At each of the four corners of the underframe a pivoting arm of special cast steel is hinged. These arms are supported on gunwales placed for this purpose for the lifting of heavy loads by means of a screw at the end of them. The area of support on the ground has been calculated so as to lower the specific maximum pressure to approximately 2 kgr./cm² (28.447 lbs per square inch.).

The bogie side supports are mounted at the ends of the cast steel crossbars.

The central panel carries :

above : a circular bed of cast steel serving as a seating for the circular roller path and for the gear wheel which forms part of the slewing gear;

below : the details driving the cardan shafts (these details can be taken down in order to allow the removal of a bogie), and also the hydraulic and screw jacks which can be supported from the ground.

The forces which this arrangement can withstand are very high.

For example, the force applied to the end of each pivoting arm attains 110 t. (108 1/4 tons) the total resistance on the rollers 412 t. (405 1/2 tons), and 217 t. (213 1/2 tons) on the check rollers.

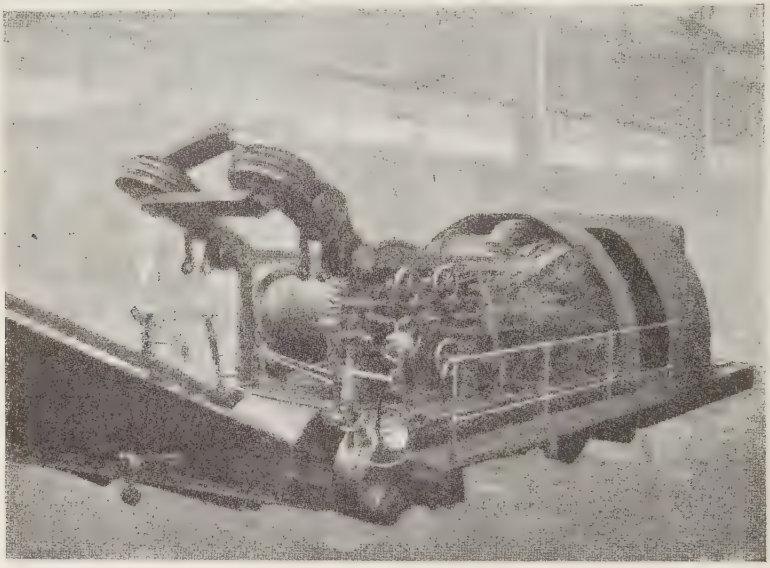


Fig. 4. — View of the winch when being fitted the driver's platform being in the foreground.

It was therefore in the case of the undercarriage absolutely essential to keep very close to the calculations.

The drawing office of the Cockerill Company created on this occasion a method of calculation by hyperstatic plans subjected simultaneously to bending and torsion. This system was described in the « L'Ossature Métallique » of September 1937 (1).

(1) The « Ossature Metallique » is a publication of the Centre Belgo-Luxembourgeois d'Information de l'Acier.

After careful study it was decided to build in all the parts, that is to say transmit simultaneously bending and torsion.

4. *Superstructure, winch, engine.*

The superstructure is of cast steel. It carries the supporting details on the underframe, the winch, the steam engine, the articulation of the bottom of the jib and the attachment of an auxiliary structure. This latter houses the boiler, the tank and bunker and the removable balance-weight.

The superstructure is supported by rollers of forged steel running on a circular road fixed to the underframe. The check rollers prevent tipping of the superstructure so that the only duty of the centre pivot is to guide.

The winch (fig. 4) is of simple and robust construction. All the controls are grouped in front. The crane driver's position is on a small movable platform from which he can easily see the field of operation. The clutches are of the claw type. The brakes carry blocks working on the conical tread of the tyres.

The lowering of the load is carried out under the double control of the brake and the engine working at counter pressure.

The engine has two cylinders with « Walschaerts » valve gear which has been very carefully made. It is fitted with mechanical lubrication and the motion is shielded by a guard.

The control of the regulator — a condition essential to the smoothness of the operation — is very satisfactory.

The boiler, which is of the Field type, has a heating surface of 35 m² (376.738 sq. ft.) and is worked at 14 Hpz (203 lbs per sq. in.). A pump with a flexible hose is able to draw water from the tank carried on the match wagon or even from streams near the track.

The cab occupies the space behind the winch and firing position. It is closed by a sliding metal shutter.

5. *Jib and accessoiries.*

The jib has a swan neck and is constructed of plate and angle brackets, and is equipped with a ladder in order that access may be gained to the upper pulleys. It is articulated in the front of the frame and is suspended by tackle consisting of 12 strands of high tensile steel cable. It carries at the end of the jib the 25 t. (24 1/2 tons) hook and a little behind the pulleys of the 130 t. (128 tons) hook.

A very powerful brake holds the wire rope winding drum. In addition a safety catch engages with the teeth of the wheel of the drum.

The radius indicator is placed on the jib and shows the actual radius measured in the horizontal plane even in cases of unevenness of the track or ground. This apparatus is very sensitive and is mounted on ball bearings.

6. *Accessories.*

The crane must be, as far as possible, independent, so that no difficulty is experienced in the execution of its work of clearing accidents. It is for this reason that it has been fitted with self travelling facilities and a water pump.

It is also for this reason that it has two complete lighting installations, electric and acetylene, each consisting of : generator (turbo-dynamo or container) revolving headlights placed in front of the superstructure and on the end of the jib, cab lamps, etc. The electric circuit can also be fed from an outside source. Pressure lubrication has, in principle, been arranged throughout. (Tecalemit mechanical lubricators grouped to hand).

7. *Match wagons.*

The wagons are of the American R. R. Z. Y. 40 t. bogie type.

One of them, which supports the 25 t. and 130 t. pulleys is equipped for the conveyance of the wood packing and beams.

The jib which is suspended by the lifting cables when in its travelling position is attached to the floor of the wagon by a spring loaded anchor chain which limits and absorbs its oscillations.

In practice, at a speed of 80 km. (50 miles) per hour these oscillations are in the region of approximately 30 mm. (1 3/16 in.).

The tackle and tools are also carried in this wagon.

The other wagon conveys the removable balance weight and the coal and water supply.

This counterweight, weighing approximately 28 t. (27 1/2 tons) runs on two solidly connected solebars of the underframe. The gap between the solebars and the back of the crane superstructure is bridged by two movable timbers operated by a wheel and endless screw.

The transference of the balance weight is carried out by a winch placed at the end of the wagon which draws the counterweight by means of a travelling platform and endless chain.

In addition this wagon carries the supply of coal and water contained in a bunker and tank fitted between the solebars.

These two wagons are equipped with hand brake, through compressed air pipe, steam and water pipes and electric conduits.

The breakdown train is completed by a coach with sleeping and mess accommodation for the staff, a covered and a flat wagon for the tackle and necessary accessories in connection with the crane.

Preparation of crane for operations.

The extent of the work required to put the crane set into operation depends on the circumstances of the case.

Small loads can be dealt with by the crane while free on the rails or only supported on the hydraulic jacks placed below the underframe. For heavy loads the crane can rest on the pivoting arms wholly or partially open. One or two bogies can be uncoupled, and the movable counterweight can be placed in position or not. The following shows possible combinations :

— Crane on 8 jacks with balance weight.

— Crane on 4 inner jacks with balance weight.

— Crane free on rail with balance weight.

— Crane on 8 jacks without balance weight.

— Crane on 4 inner jacks, without balance weight.

— Crane free on rails without balance weight.

— Crane without bogies on 8 jacks with balance weight.

— Crane without bogies on 8 jacks without balance weight.

— Crane with jacks open to 45° with balance weight.

— Crane with jacks open to 45° without balance weight.

The most complete operation, that is to say the removal of the two bogies includes the following essential operations :

(*a*) Removal of the anchorage and lifting of the jib in order to disengage the pulleys;

(*b*) Removal of the buffer beam from the end at which the bogie is withdrawn from under the crane;

(*c*) Removal of the bogie pins and cardan shafts of the travelling arrangement;

(*d*) Placing in position the supporting timbers and lifting the crane by means of the hydraulic jacks provided for this purpose;

(*e*) Station one bogie under the crane remove the other beyond the field of operation;

(*f*) Lower the crane on to the replaced

bogie and support by means of screw jacks;

(*g*) Attach the counterweight.

Fig. 5 shows the crane with one bogie removed and the other placed below the undercarriage.

With a trained staff and ground of ordinary character free of obstructions, no more than an hour elapses between the arrival of the crane at the spot where the hoisting is to be done and the moment when it is ready to lift its maximum load. When lifting lighter loads, this time can be lessened.

It is, of course, indispenable that the crane should be taken rapidly to the place where it is to be used and a speed of 80 km. (50 miles) per hour has been attained without difficulty.

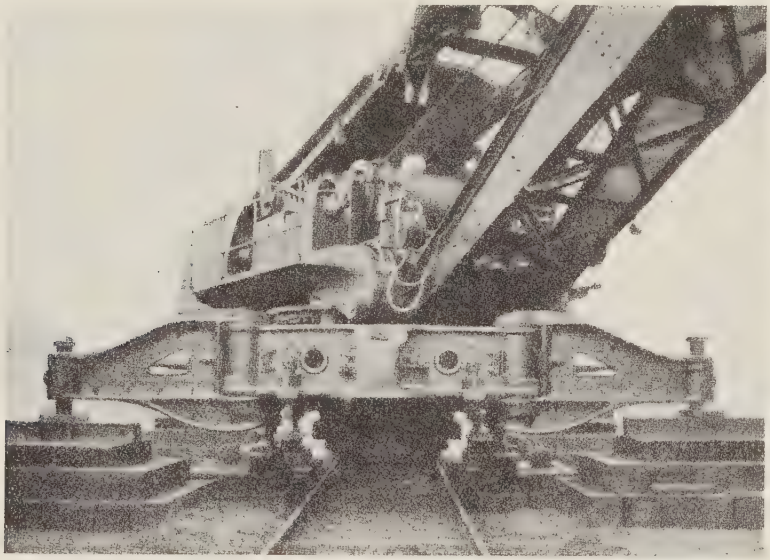


Fig. 5. — End of crane with bogie withdrawn.

Trials.

The trials were carried out at Bretigny station. They included the following operations :

(*a*) Hoisting and slewing 60 t. (59 tons) and 130 t. (128 tons) at 10 m. (32 ft. 10 3/4 in.) and 6.250 m. (20 ft. 6 3/32 in.) radii respectively;

(*b*) Lifting of trial loads of 72 and 156 t. (71 and 153 1/2 tons) at the same radii and in both cases with the jib in the centre of the track and the jib placed at right angles to the rails;

(*c*) Lifting the jib under a load of 60 t. (59 tons) at 10 m. (32 ft. 10 3/4 in.) radius;

(*d*) Measuring the speeds of all movements when loaded;

(*e*) Lifting a load of 90 t. (88 1/2 tons) at 9.55 m. (31 ft. 5 1/16 in.) radius;

(*f*) Lifting a load of 52 t. (51 tons) at 6.25 m. (20 ft. 6 3/32 in.) radius, the crane being placed on the 4 inner jacks;

(*g*) Lifting a load of 18 t. (17 3/4 tons) at 10 m. (32 ft. 10 3/4 in.) radius, the crane being free on the rails;

(*h*) Lifting the test load of 37.5 t. (36 tons 18 cwts) by the movement for lifting 25 t. (24 tons 12 cwts);

(*i*) Checking the stability of the crane free on rails with counterweight;

(*j*) Hoisting the maximum proposed load with crane without counterweight;

(*k*) Preparing for operations, replacing the crane in convoy and making running trials at a speed of 80 km. (50 miles) per hour.

The test loads consisted of rails supported by special cradles.

The trials have been entirely satisfactory. All estimated speeds of operation have been greatly surpassed, although the ground was of a rather mediocre consistency, especially when saturated by rain, the subsidence under the supports was small and did not impede operations.

[625. 251]

Braking high-speed trains,

by C D. STEWART,
(The Railway Mechanical Engineer.)

The stress of war brings technological improvements in months that under less strenuous circumstances take years to achieve. And because modern warfare is so highly mechanized, the nature of many of these improvements is of necessity mechanical. Furthermore, since this particular war is global in character, transportation is one of the most vital services. Therefore, as we would expect, the greatest improvements are being made in the newer means of transportation. This newer means, of course, being air-borne transportation.

It is most fitting, therefore, that those of us who are interested in rail transport take stock in order that when peace comes we will not be unprepared for the adjustment that must follow. It seems to me that it would be worthwhile to analyze briefly what place other means of transportation may have in our post war world so that we may be better prepared to say what changes or improvements may be advisable and desirable in rail transport.

Of these other means, air-borne transport comes first to mind because it has speed for its major appeal. Next in importance is highway transport because under our present state and national public highway policy, low direct cost is possible. Furthermore, undoubtedly the great Pennsylvania Turnpike will be used as a model for many additional miles of new construction. Therefore, highway transportation will have additional new advantages. In these two competitive transportation systems, we have two basic reasons for keen competetition, namely, speed in the one, low cost in the other.

Even if we were so minded, there is little that anyone could do to make these two modern forms of transportation less appealing, but on the other hand, the situation is not as hopeless as some people would have us believe. Either because of wishful thinking or because of lack of full information, there are some who predict the gradual ending of the railways' usefulness. This type of observation has advanced to the point that numerous men in high positions have attempted to draw a more reasonable picture of the future of transportation.

W. A. Patterson, president United Air Lines, before meeting of the Railroad Securities Committee of the Investment Bankers' Association of America, stated :

« The future of the airplane in commerce is indeed great, but it appears that this future will be realized without serious embarrassment to the steamship lines or to the railroads. The volume of domestic air cargo could increase one hundredfold and yet capture only one-tenth of one per cent of the freight-ton miles now carried by the American railroads. Our economy demands the services of all the various types of transport media, each fulfilling the requirements peculiar to its own inherent characteristics. It would appear that the airplane can not supplant, but instead it will supplement the railroads. »

It is well and good that the railroads be considered an institution of public necessity but that does not of itself insure sufficient business to make operations profitable. The other agencies will attempt to increase their former share of goods for haul and they will have striking advantages with the im-

returns are immediately available from each modern brake equipment that is added to existing trains in that the stopping distance is shortened in direct proportion to the increase in the number of such equipments in any train.

For wheel-slip protection the speed-control generator is used also for the protection of its particular axle and the same type of electric generator is added to each of the other axles of the train. Two of the electric relays used for speed-governor control are likewise given a dual function to perform, and other electric relays of similar appearance and size, but different in function, are added to the relay panel. As you will recall, we stated that the electric relays used for speed-pressure control are constructed so as to be responsive to a certain *speed,* having in mind that speed and voltage values are synonymous. The electric relays used for wheel-slip protection on the other hand are so constructed as to be responsive to a certain rate of *change in speed.* There is no difficulty whatever in having these relays designed to ignore the rates of change in speed that are incident to normal stopping of the train and yet infallibly recognize rates of change in speed incident to a wheel commencing to slip.

For example, the normal retardation rate of a train is about two and one-half miles per hour per second, and it may reach under unusual conditions five or perhaps five and one-half miles per hour per second. On the other hand, a wheel slipping to a stop may reach a rate of deceleration of 100 m.p.h. per second. The latitude this situation affords is so broad that we are free to select almost any rate we care to employ with our wheel-slip control relay. We have chosen the rate of 10 m.p.h. per sec., first, because it provides sufficient margin above the maximum train retardation rate to insure against unintentional functioning, and yet incipient wheel sliding is detected early enough to make possible the lowering of brake-cylinder pressure in time to avoid the wheel coming to a complete slide. In fact, we have taken graphic records of wheel retardation in actual road operation and have been fortunate enough to record graphically incipient wheel sliding, and in some cases the reaction of the wheel-slip controller was so prompt that it required careful analysis of the records to locate the change in the pattern produced by the wheel first slowing down and then resuming train speed.

Makes maximum brake performance possible.

It may be asked if this anti-wheel-slip device, which we have termed Decelostat, will lenghten the stopping distance if it functions as a result of a wheel slipping, and particularly in high speeds. The answer is that it does not, as has been demonstrated by actual road tests. As a matter of fact, the stopping distance is shortened because a sliding wheel is not as effective in stopping a vehicle as one braked just under the point of wheel sliding. The ability materially to increase the braking effort in the manner in which we have described makes possible consistent maximum brake performance under all kinds of adverse conditions, equivalent to the best performance that otherwise is only possible under the most favorable rail conditions.

[621. 431. 72 (.73) & 656. 212. 5 (.73)

Diesel trailers for hump operation.

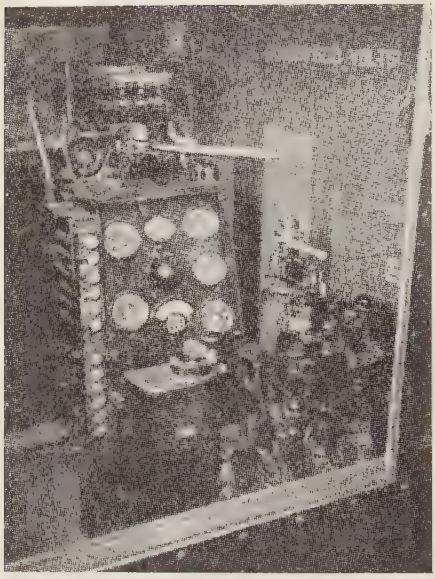
(The Railway Age.)

Increased operating efficiency has been obtained in the classification of freight trains in five major freight yards on the New York Central by the use of Diesel-electric switcher-type locomotives equipped with electric trailers. The trailers, converted from old electric locomotives, have four motors which are connected in series with those on the locomotive while pushing trains. This arrangement provides enough weight on drivers and sufficient motor capacity to give sustained high tractive force at speeds of two to four miles an hour. When the train has been pushed over the hump, the traction motors on the trailer are disconnected and the locomotive is free to run at any speed up to 60 m. p. h., hauling the trailer.

Diesel hump locomotives, combining switcher and trailer, are now in service on the westbound humps in the yards at Selkirk, N. Y., DeWitt, N. Y., Gardenville, N. Y., and Detroit, Mich. Be-

. A single-end pusher with a 1 000-hp. locomotive.

Double-end pusher with two 1 000-hp. Diesel-electric locomotives.

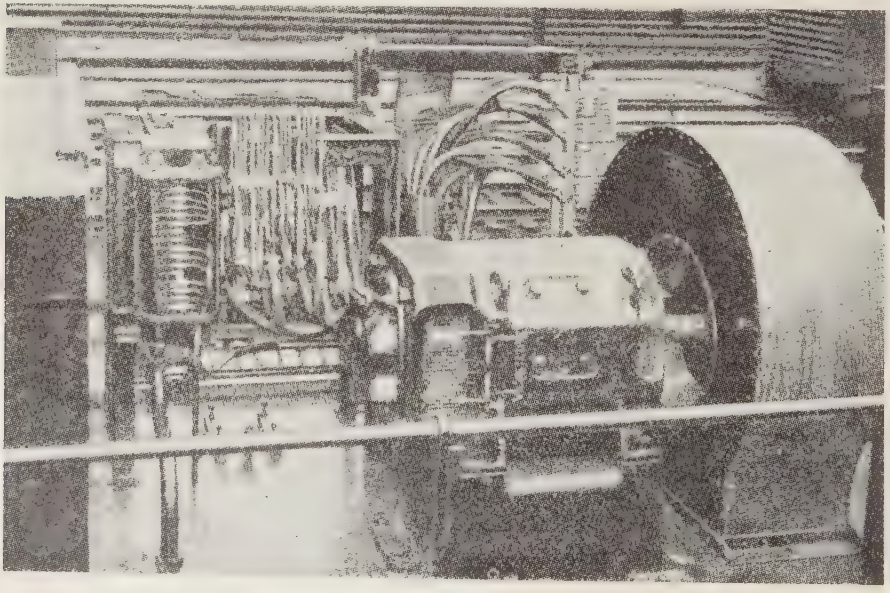


Controller showing air-operated throttle which has been added to locomotives used with the double-end trailers.

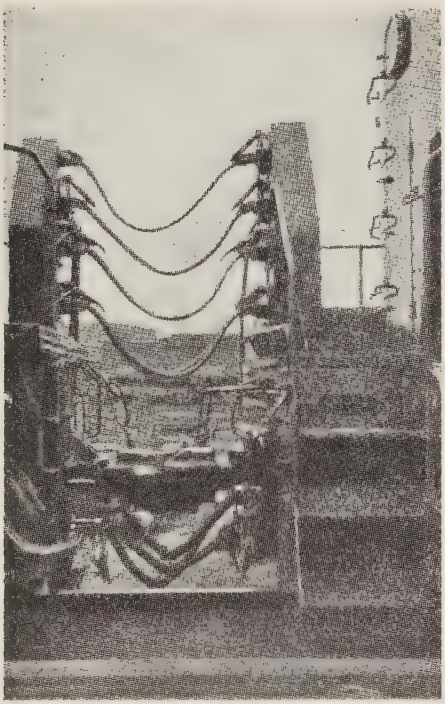
cause of the heavier trains and a steeper grade on the hump of the eastbound classification yard at DeWitt, a hump locomotive made up of two switchers and a trailer is used.

The Mallet locomotives displaced exerted a tractive force of 95 730 lb. A single 1 000-hp. Diesel with a trailer has a maximum tractive force of 119 500 lb.; a single 600-hp. Diesel with a trailer develops 109 000 lb.; and two 1 000-hp. Diesels with a trailer are capable of developing 171 000 lb. The single-end trailers weigh 253 700 lb. and the double-end 266 100 lb. The single-end units handle trains up to approximately 4 000 tons while the double-end units are used with maximum trains of approximately 8 000 tons.

The single-end trailers were converted from type RA electric locomotives, the cabs being removed and replaced with housings for sanders, blower, control equipment and ballast. The ballast on the single-end units consists of scrap rails



Motor-driven blower and control equipment on a single-end trailer.



Connections between a locomotive and one of the single-end trailers.

or 4-in. plate laid on the floor casting, and concrete and steel ballast blocks over the center plate and in openings in the underframe.

The trailers have GE-286 motors. The gear ratio is 69/20. Alco locomotives were selected for this service because they have series-parallel control permitting high-speed return movements and because the locomotive and trailer motor characteristics are essentially similar. The control is interlocked so that the series-parallel connection of motors on the switchers cannot be used when the trailer motors are in the circuit.

A motor-driven blower and control equipment consisting of contactors and reverser are located in the center housing of the single-end trailers The blower has a capacity of approximately 8 500 c.f.m. at 4-in. pressure when running at 1 260 r.p.m. and is driven by a 19.5-hp. motor from the Diesel locomotive generator. The speed of the blower varies with the generator voltage. The blower is kept running when trailer traction motors are disconnected and the locomotive is making a return trip. This assures low initial motor temperatures at the beginning of each pushing operation.

Locomotive and trailer motors are equipped for weight compensation. This consists of applying a shunt to the field of the motor driving the leading and more lightly loaded axle on each truck. It is accomplished on the 1 000-hp. locomotives with a foot switch and is automatic on the 600-hp. locomotives.

Electrical connections between the locomotive and single-end trailer are made through one 7-conductor jumper, one 16-conductor jumper, two bus jumpers and appropriate receptacles. Brakes are straight air and sanders are electro-magnetic, all being controlled from the operating position in the locomotive.

There is one double-end trailer in service and one nearing completion. The one in service was made from the original „three-power" locomotive designed for operation from a Diesel power plant or a battery on the locomotive or from the third rail in the New York electrified territory. The two 1 000-hp. locomotives are connected to opposite ends of the trailer and each supplies power to the motors on one trailer truck in addition to its own motors. Added ballast on the trailer consists of a number of layers of scrap rail, all on the top deck. Two blowers and a sand box are contained in each end housing and control equipment in the center housing. A motor-transfer switch can be used to connect all of the trailer motors in series for operation with one locomotive only. For use with the double-end trailers, the locomotives are equipped with air-operated throttle control to secure multiple-unit operation of the locomotives.

NEW BOOKS AND PUBLICATIONS.

[385. (09 (.493)]

LAMALLE (Ulysse), Ingénieur Civil des Mines, A. I. Lg., Professor of the railway operating course at the University of Louvain, Honorary General Manager of the Belgian National Railways Company. — **Histoire des chemins de fer belges** *(History of the Belgian Railways)*. — One volume (4 7/8 × 7 5/8 inches) of 158 pages with 82 figures and 8 separated plates. — Brussels : Office de Publicité, anciens Etablissements J. Lebègue & Cie, Publishers, 36, rue Neuve. (Price : 30 Belg. francs).

The « Office de Publicité », a Brussels publishing house, has issued a remarkable series of works in two different collections, the Lebegue Library, and the National Library. A very wide field of subjects is dealt with. The former collection consists mainly of essays on classical authors, Greek and Latin writers, poets, orators and philosophers, as well as several French and Belgian authors. The authors who have collaborated in the National Library give the reader a choice selection of articles on Belgian literature and history, with monographs on writers, artists, sages, politicians, inventors, and social reformers.

Mr. Lamalle's new book finds its due place in the National Library, in which it is published as an extra volume. It is amply justified by the important part played by the railways in the industrial and social development of Belgium over many long years of growing prosperity.

It was certainly a difficult undertaking to write the history of the Belgian railways in so few pages. The task was only possible for someone capable of making the fullest use of the copious documentation available. The author was well fitted for the task having during his lengthy career played an active part in the life of the railway and for many years been responsible for managing the most executive department of this important organisation. A special aptitude for synthesis, invaluable in teaching, was another guarantee of his success.

Although the law authorising the construction of a railway system in Belgium was passed on the 1st May 1834, and the solemn inauguration of the Brussels to Malines line took place one year later on the 5th May 1835, we must go much further back to discover the origins of the new method of transport. The author begins by a brief reminder that the railway had its origins in the mines and left its underground life to conquer new spheres above ground. He links this up with the birth of the locomotive, which based on the steam engine already widely used in 1800, after a series of inventions combined two fruitful ideas which assured its power and adaptability.

Technical improvements in themselves, however, would not have sufficed to bring to fruition and undertaking, the future development of which no-one could have foreseen at that time. Those political and economic conditions which made the creation of a new method of communications desirable also played an essential part. Chapter III of the first part (The heroic age) is perhaps the most striking of the book. Here we are indeed witnessing the birth of the railway in Belgium, at the same time as historical events of supreme importance to the country. How moving is the description of the 5th May 1835, « *une belle journee* » as he calls it, which marks the beginning of the era of public railway transport on the Continent.

Further on we see the evolution of the railway under its various aspects : technical equipment, organisation of transport, commercial aspect, financial results; and we can appreciate the milestones which mark this great century of progress. But above all the interest aroused by the enthousiasm of those early years is concentrated on the creation and establishment of lines. In this recital of the heterogeneous lines which ended up by constituting the unified railway system of today, it is both the historian and the economist who is writing.

There are many opportunities of pointing out personal initiative, and the Belgian reader will feel considerable satisfaction in seeing tribute paid to inventions which were made in his native land, for example such purely technical problems in the case of the locomotive as the invention of valve gear, or the creation of a firebox for burning slack, the use of superheated steam or improvement of the draught, while the rolling stock benefited by inventions relating to lighting, heating, and automatic brakes. Here it is the technician who is speaking, and he does not overlook either the change in the superstructure of the track, the strength of which is increased as the speeds and loads increased, nor important structures, nor all that has been demanded of electricity for safety requirements in the case of signalling.

Another remarkable Belgian innovation is to be found in the goods rates which have been thoroughly revised on many occasions, and that is rates on a decreasing scale, a system which has been adopted by most of the large railways owing to its flexibility. This question of the rates led naturally to a chapter on the competition of other methods of transport, a subject of vital interest to the railway.

In the seventh and last part, the author gives a true picture of the essential financial results as reporter by the railways from the beginning up to the formation of the Belgian National Railways. He reports the circumstances under which the latter took over the operation of the system in 1926, and the good results of its management in spite of the very great difficulties of the last few years.

We cannot end this rapid review without mentioning the happy choice of illustrations, particularly the engravings collected in plates outside the text. Portraits of men whose names are intimately connected with the birth or evolution of the railway, photographs of celebrated engines and characteristic equipment, historic scenes, the milestone of Malines, and the commemorative medal of the 1st May 1834, are worthy illustrations for this historical book.

MONTHLY BIBLIOGRAPHY OF RAILWAYS[1]

PUBLISHED UNDER THE SUPERVISION OF

P. GHILAIN,

General Secretary of the Permanent Commission of the International Railway Congress Association.

(JUNE 1946)

[016. 385. (02]

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In French.

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Le matériel roulant des Chemins de fer français.

Paris, L. Eyrolles, édit. 1 volume in-8° (14 × 25 cm.) V-315 pages, 135 figures.

1943 669

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Les grands problèmes de la métallurgie moderne.

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Tableaux pour le calcul rapide des poutres à âme pleine vées et soudées.

Bruxelles, Le Centre Belgo-Luxembourgeois d'Informan de l'Acier en collaboration avec l'Union des Constructrs Belges de Ponts. Un album (21 × 30 cm.) de 2 pages, dont 96 tableaux.

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L'expérience et les théories nouvelles en résistance des tériaux.

Paris (6e), Dunod, éditeur. Un volume (13 × 21 cm.) 139 pages, avec 36 figures.

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Influence de la déformabilité aux efforts tranchants sur résistance au flambage des poutres à âme pleine ou treillis.

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Liége, Desoer, éditeur. 1 volume (16 × 24 cm.) de 447 pages, 357 figures. (Prix : 350 francs.)

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Heating, Ventilating, Air Conditioning Guide. Vol. 18.

A volume (6 × 9 inches), of 1 088 pages; illustrated; diagrams, charts, tables. 1940; Published by the Society, New York, N. Y. (Price: clothbound, $ 5.)

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Electric Transportation (City surface cars, buses, ways, elevated systems, main railways).

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1943 **624. 2**

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DELPUECH (P.). — La **torsion dans les ponts métal-iques.** (10 000 mots & fig.)

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1941 **624 .8 (.493)**
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1942 **625 .13 (.493)**
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PAUWEN (L.-J.). — Le tracé topographique des **tunnels** sous l'Escaut à Anvers. (28 000 mots, tableaux & fig.)

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MULS (F.). — Le calcul des **rivures d'attache des goussets aux membrures.** (2 200 mots & fig.)

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MARKOVIC (D.). — Suggestions relatives à la re sion de la **Convention internationale concernant le tra port des marchandises** par chemin de fer. (17 000 mot

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1941 **625 .144 .3**

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1942 **62. (01 & 691**

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fig.)

1942 **621 .436**

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1942 **621 .33 (.494)**

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1943 **625 .232 (.460)**

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1944 **621 .335 (.494)**

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REMY (X.). — Coordination et modernisation du
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1944 **625 .41**

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1941 **62. (01 & 624**

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LEINEKUGEL LE COCQ (G.). — L'emploi de bâches remplies d'eau pour les **épreuves de poids mort des ponts.** (2 000 mots & fig.)

1941 **629 .113 .4**

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1941 **625 .42 (.44)**

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1941 **621 .431 .72 (.44)**

Génie Civil, nº 3035-3036, 12 avril-19 avril, p. 158.
Les **autorails à gazogène à bois** du Département des Landes. (1 200 mots & fig.)

1941 **62. (01 & 721 .9**

Génie Civil, nº 3039-3040, 10 mai-17 mai, p. 190.
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1941 **629 .113 .65**

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1941 **62. (01 & 691**

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1941 **669 .1**

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1941 **621 .89**

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1941 **624 .6**

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1941 **624 .63 (.44)**

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1941 **669 .1**
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1941 **624 .2**
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PIGEAUD (G.). — Le calcul des **poutres chargées.** Introduction de la tension N_2. (12 500 mots & fig.)

1941 **662**
Génie Civil, n° 3047-3048, 5-12 juillet, p. 15.
L'emploi d'ammoniaque et d'oxyde de méthyle comme **carburant** pour les automobiles. (850 mots & fig.)

1941 **385 .113 (.44) & 625 .42 (.44)**
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L'**exploitation** du Chemin de fer Métropolitain de Paris en 1940. (1 300 mots & fig.)

1941 **625 .143 .2 & 669 .1**
Génie Civil, n° 3051-3052, 2-9 août, p. 62.
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JEANCARD (H.). — L'**électrification** du Chemin de fer suisse de Biere-Apples-Morges (B. A. M.). (1 500 mots & fig.)

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1945 **721 .1**
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KERKHOFS (W.). — Colonnes encastrées dans une **fondation** posant sur terrain élastique. (1 200 mots & fig.)

1945 **623 (.44)**
L'Ossature métallique, mars-avril, p. 47.
Le **Port artificiel** d'Arromanches. (1 700 mots & fig.)

1945 **669 & 665 .882**
L'Ossature métallique, mars-avril, p. 67.
PAPPI (R.). — La **trempe superficielle** oxy-acétylénique. (2 200 mots & fig.)

1945 **62. (01 & 669**
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MIRONOFF (N.). — Une nouvelle méthode d'**essais micro-mécaniques des métaux.** (1 100 mots & fig.)

1945 **623 (.493) & 624 (.493)**
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LEMAIRE (C.-F.-B.). — La destruction des **ponts-rails métalliques** pendant la guerre. (4 000 mots & fig.)

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1941 **625 .11 (.44) & 656 .211 (.44**
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LACHENY & GERVIE. — Les **réalisations projetée** dans la région lyonnaise. (4 000 mots, 2 planches & fig.

1941 **385 .57 (.44**
Revue générale des chemins de fer, n° 4, juil.-août, p. 234
Le **recrutement** et la **formation** du personnel du cadr permanent à la S. N. C. F. (3 800 mots & fig.)

1941 **625 .111 (.66**
Revue générale des chemins de fer, n° 5, sept.-oct., p. 249
MAITRE-DEVALLON. — La construction du **Médi terranée-Niger.** (3 600 mots, 1 carte & fig.)

1941 **625 .245 (.44) & 656 .223 .2 (.44**
Revue générale des chemins de fer, n° 5, sept.-oct., p. 258
PELLARIN. — La **Société de Gérance des Wagon de grande capacité.** (7 500 mots & fig.)

1941 **385 .517 (.44**
Revue générale des chemins de fer, n° 5, sept.-oct., p. 269
Dr. OBERLIN & MIRET. — Le **centre d'hygiène** d Villeneuve-Saint-Georges. (2 000 mots & fig.)

1941 **656 .222 .5 (.44**
Revue générale des chemins de fer, n° 5, sept.-oct., p. 276
ARMAND & GARIN. — La détermination des **horaire** des trains de voyageurs sur la Région du Sud-Est. (6 50 mots & fig.)

1941 **656 .212 (.44**
Revue générale des chemins de fer, n° 6, nov.-déc., p. 305
SEPTIER. — **Travaux** sur la Région de l'Est. (4 20 mots & fig.)

1941 **625 .245 (.44**
Revue générale des chemins de fer, n° 6, nov.-déc., p. 334
FORESTIER & LEJEUNE. — Nouveaux types d **wagons pour chargements exceptionnels** étudiés par l S. N. C. F. et mis en construction avant les hostilités (1 200 mots & fig.)

1941 **625 .143 (.44) & 656 .25 (.44**
Revue générale des chemins de fer, n° 6, nov.-déc., p. 342
WALTER & LEPAGE. — **Insertion de bandes de méta inoxydable dans le champignon des rails** à la gare d'A genteuil-Etat pour éviter les **incidents de signalisation** (1 200 mots & fig.)

1941 **625 .142 .2 (.44**
Revue générale des chemins de fer, n° 6, nov.-déc., p. 347
DELOR (G.). — Nouveau mode de consolidation pa frettage des **traverses en bois** pour chemin de fer. (1 20 mots & fig.)

1942 **624 (.44**
Revue générale des chemins de fer, n° 1, janv.-fév., p. 3
LEMAIRE (M.). — La **reconstruction des ouvrage d'art** de la S. N. C. F. (2 000 mots, 2 tableaux & fig.

1942 **625 .13 & 625 .22**
Revue générale des chemins de fer, nº 1, janv.-fév., p. 19.
BOUTELOUP. — Un **appareil enregistreur des dimensions des souterrains** dit appareil palpeur-mesureur Castan. (4 500 mots & fig.)

1942 **656 .254 (.44)**
Revue générale des chemins de fer, nº 1, janv.-fév., p. 30.
GILMAIRE. — Les **postes de commandement** de la Région du Sud-Ouest. (7 000 mots & fig.)

1942 **621 .138 .5 (.44) & 621 .382 (.44)**
Revue générale des chemins de fer, nº 1, janv.-fév., p. 46.
BIAIS. — Applications et conditions de mise en œuvre de la **soudure à l'arc électrique** dans les ateliers de réparations de locomotives et tenders de la S. N. C. F. (6 000 mots & fig.)

1942 **656 .257 (.44)**
Revue générale des chemins de fer, nº 1, janv.-fév., p. 60.
WALTER. — Comment la S. N. C. F. unifie ses **installations électriques et de signalisation** et coordonne leurs règles de montage et d'entretien. (6 000 mots & fig.)

1942 **385 .5 (.44)**
Revue générale des chemins de fer, nº 1, janv.-fév., p. 73.
ANCELIN. — Un essai de nouvelles **méthodes d'administration du personnel** du 1er arrondissement de l'exploitation de la Région du Nord. (4 000 mots & fig.)

Revue Universelle des Mines. (Liége.)

1941 **62. (01**
Revue universelle des Mines, nº 2, p. 73.
MASSONNET (Ch.). — **Flambage par torsion.** (3 000 mots & fig.)

1941 **62. (01**
Revue universelle des Mines, nº 4, p. 145.
GUYOT (F.). — Les **rayons Gamma** au service de l'industrie. (6 500 mots & fig.)

1941 **669**
Revue universelle des Mines, nº 11, p. 318.
SCHOOFS (J.). — Les **alliages de remplacement** pour les laitons et les bronzes. (5 000 mots, 6 tableaux & fig.)

1941 **62. (01 & 669 .1**
Revue universelle des Mines, nº 11, p. 338.
DEHALU (J.-M.). — Le problème du choix des **aciers en construction mécanique.** (3 000 mots, 1 tableau & fig.)

1942 **656 .251**
Revue universelle des Mines, nº 1, p. 12.
GENARD (J.). — Note sur la valeur colorimétrique de certains **verres de signalisation de chemins de fer.** (1 900 mots & fig.)

1942 **662**
Revue universelle des Mines, nº 1, p. 16.
BERTRAND (M.-F.). — Caractéristiques des **charbons pour gazogènes.** (2 000 mots & fig.)

1942 **624 .2**
Revue universelle des Mines, nº 2, p. 29.
MULS (F.). — Théorie analytique des lignes d'influence des **poutres Vierendeel.** (3 500 mots, tableaux & fig.)

1942 **621 .436**
Revue universelle des Mines, nº 2, p. 43.
JADOT (A.). — Le **moteur Diesel au gaz** ou moteur à gaz à allumage par injection de gas-oil. (2 700 mots & fig.)

Science et Vie. (Paris.)

1946 **621 .132 .3 (.44) & 621 .132 .5 (.44)**
Science et Vie, janvier, p. 10.
MARCHAND (J.). — **Locomotives américaines** en France. (1 500 mots & fig.)

1946 **656 .25 (.44)**
Science et Vie, janvier, p. 33.
LEMONNIER (A.). — **Signaux et postes d'aiguillage.** (8 000 mots & fig.)

La Technique moderne. (Paris.)

1941 **621 .431 .72 (.81)**
La Technique moderne, nos 3 et 4, 1er et 15 février, p. 50.
Nouveaux **trains Diesel** de luxe en Amérique du Sud. (400 mots & fig.)

1941 **625 .154 (.73)**
La Technique moderne, nos 3 et 4, 1er et 15 février, p. 50.
Ponts tournants de 41 m. pour locomotives. (350 mots & fig.)

1941 **621 .392 & 669 .1**
La Technique moderne, nos 5 et 6, 1er et 15 mars, p. 70.
VOLFF (Ch.). — L'**acier AC. 54,** acier de construction à haute résistance et ses qualités de soudabilité. (5 000 mots & fig.)

1941 **621 .33**
La Technique moderne, nos 5 et 6, 1er et 15 mars, p. 83.
L'ignitron et ses applications à l'industrie des transports. (1 800 mots & fig.)

1941 **621 .33 & 654**
La Technique moderne, nos 7 et 8, 1er et 15 avril, p. 119.
Influences des installations ferroviaires à courant alternatif sur les câbles à longue distance. (1 000 mots.)

1941 **621 .431 .72 (.44)**
La Technique moderne, nos 9 et 10, 1er et 15 mai, p. 146.
Autorail Diesel-électrique à deux étages. (200 mots & fig.)

1941 **621 .431 .72 (.44) & 621 .433 (.44)**
La Technique moderne, nos 9 et 10, 1er et 15 mai, p. 147.
Autorail au gaz de bois en France. (200 mots & fig.)

1941 **621 .132 .3 (.44)**
La Technique moderne, nos 9 et 10, 1er et 15 mai, p. 147.
Locomotive compound à 4 cylindres du type 230. (200 mots & fig.)

1941 **621 .431 .72 (.44)**
La Technique moderne, nos 11 et 12, 1er et 15 juin, p. 180.
Une nouvelle **automotrice Diesel-mécanique.** (300 mots & fig.)

1941 **621 .33 (.460)**
La Technique moderne, nos 11 et 12, 1er et 15 juin, p. 180.
L'**électrification** des Chemins de fer espagnols. (800 mots.)

1941 **621 .431 .72 (.494)**
La Technique moderne, nos 11 et 12, 1er et 15 juin, p. 182.
La **locomotive Diesel-électrique** no 1001 des Chemins de fer suisses. (600 mots & fig.)

In German.

Archiv für Eisenbahnwesen. (Berlin.)

1941 **656 .235. (0**
Archiv für Eisenbahnwesen, Januar/Februar, S. 1; März/April, S. 169.
SPIESS (W.). — Der **Eisenbahngütertarif in der Volkswirtschaft.** (60 000 Wörter.)

1941 **385. (01 (.6)**
Archiv für Eisenbahnwesen, Januar/Februar, S. 49.
WEISS (E.). — **Eisenbahn-Vorarbeiten** bei Bahnbauten in Afrika. (19 000 Wörter und 2 Tafeln.)

1941 **656 (.71)**
Archiv für Eisenbahnwesen, Januar/Februar, S. 87.
PASCHEN (W.). — Das **Verkehrswesen** Kanadas und seine Probleme. (17 000 Wörter, Tafeln & Karte.)

1941 **385 .526 (.43)**
Archiv für Eisenbahnwesen, März/April, S. 247; Mai/Juni, S. 405.
DUERDOTH (H. A.). — **Unfallversicherung, Beamten-unfallfürsorge** und Reichsbahn. (55 000 Wörter.)

1941 **385. (093 (.45)**
Archiv für Eisenbahnwesen, März-April, S. 305.
WERNEKKE. — Die **ersten hundert Jahre** der italienischen Eisenbahnen 1839-1939. (13 000 Wörter & 1 Karte.)

1941 **313 .385 (.56)**
Archiv für Eisenbahnwesen, März/April, S. 336.
Die **türkischen Staatsbahnen** in den Jahren 1938/39 und 1939/40. (1 800 Wörter & 1 Karte.)

1941 **656 (.6)**
Archiv für Eisenbahnwesen, Mai/Juni, S. 365.
REMY. — Die **Afrikanische Verkehrsfrage** auf der Volta-Tagung zu Rom 1938. (8 000 Wörter, 4 Zusammenstellungen & Karten.)

Der Bahn-Ingenieur. (Berlin.)

1940 **621 .138 .5 (.43)**
Der Bahn-Ingenieur, Nr. 29, 21. Juli, S. 359.
MENGLER. — **Stoffersparnis** in den Lokomotiv-Ausbesserungswerken. (2 700 Wörter & Abb.)

1940 **656 .257**
Der Bahn-Ingenieur, Nr. 30, 28. Juli, S. 373.
CHAUSSETTE (G.). — **Zugschlusstellen.** (2 300 Wörter & Abb.)

1940 **621 .136 .2**
Der Bahn-Ingenieur, Nr. 30, 28. Juli, p. 378.
PFAFF. — Vorrichtung zum **Kuppeln von Lokomotiven und Tender.** (450 Wörter & Abb.)

1940 **621 .392**
Der Bahn-Ingenieur, Nr. 31, 4. August, S. 385.
GRÜNDLER. — Das **elektrische Warmschweissen** grösserer Gussstücke in der gasbeheizten Schweissgrube. (1 600 Wörter & Abb.)

1940 **625 .144 .3**
Der Bahn-Ingenieur, Nr. 31, 4. August, S. 389.
BÄRENZ (J.). — Berechnung von Schnittpunkten und Winkeln im **Übergangsbogen.** (500 Wörter & Abb.)

1940 **621 .134 .1 & 621 .392**
Der Bahn-Ingenieur, Nr. 32, 11. August, S. 399.
STACH. — Das **Schweissen von Treib- und Kuppelstangen** mittels Lichtbogenschweissung. (300 Wörter.)

Elektrische Bahnen. (Berlin.)

1941 **621 .336**
Elektrische Bahnen, Heft 3, März, S. 45.
KASPEROWSKI (O.). — **Arbeits- und Kurzschluss-stromverluste** bei Schichtbürsten. (4 000 Wörter & Abb.)

1941 **621 .333 (.43)**
Elektrische Bahnen, Heft 3, März, S. 51.
STIX (R.). — Der **Einphasenmotor ASM 701** der Lokomotiv-Reihe E 18² der Deutschen Reichsbahn. (3 500 Wörter & Abb.)

1941 **621 .332**
Elektrische Bahnen, Heft 3, März, S. 55.
KLAUDY (P.). — Elektrische und thermische Untersuchungen an **Fahrdrähten** aus Heimstoffen und aus Kupfer. (5 000 Wörter, 1 Tafel & Abb.)

1941 **621 .332 (.43)**
Elektrische Bahnen, Heft 4, April, S. 65.
GEBAUER (C.). — **Netzkupplungsumformer** als Bahnstromlieferer für die Deutsche Reichsbahn. (4 500 Wörter & Abb.)

1941 **621 .332 (.45)**
Elektrische Bahnen, Heft 4, April, S. 71.
MUSSO (G.) & VIRGILI (E.). — **Frequenz-Umformerwerke** für das Zugförderungsnetz der italienischen Gleichstrombahnen. (5 000 Wörter & Abb.)

1941 **621 .332**
Elektrische Bahnen, Heft 4, April, S. 77.
de MARTINI (V.). — Der ruhende **Frequenzwandler** zur Kupplung unabhängiger Drehstromnetze. (4 500 Wörter & Abb.)

1941 **621 .33**
ektrische Bahnen, Heft 5, Mai, S. 85.
KOTHER (H.). — Eignung des **elektrischen Zugbe-iebes** für Massengüter- und Fernschnellverkehr. (2 200 örter, 1 Tafel & Abb.)

1941 **621 .331**
ektrische Bahnen, Heft 5, Mai, S. 89.
KRIENITZ (G.). — Der **Anschluss von Kraftwerken d Unterwerken** an die Fernleitung. (5 500 Wörter Abb.)

1941 **62. (08**
ektrische Bahnen, Heft 5, Mai, S. 95.
SCHILLING (H.). — **ISA-Passungen.** (4 500 Wörter Abb.)

Glasers Annalen. (Berlin.)

1940 **625 .245**
asers Annalen, Heft 20, 15. Oktober, S. 207.
KÖPKE (L.). — **Leichtkesselwagen.** (3 000 Wörter, Tabelle & Abb.)

1940 **621 .133 .3**
asers Annalen, Heft 21, 1. November, S. 215.
FLECKSEDER (H.). — Studie zum Umbau eines **okomotivüberhitzers.** (4 200 Wörter, 1 Zahlentafel Abb.)

1940 **621 .132 .6 (.43)**
asers Annalen, Heft 22, 15. November, S. 223.
ADAMS (W.) & BRÖTZ (W.). — Die **1E1-Lokomotive** r Westfälischen Landes-Eisenbahn-Gesellschaft. (Beschreibung der Bauart und Gedanken zur Vereinheitlichung der Dampflokomotiven der nichtreichseigenen senbahnen. (2 500 Wörter & Abb.)

1940 **621 .13 (.73) & 625 .2 (.73)**
asers Annalen, Heft 22, 15. November, S. 227; Heft 24, 15. Dezember, S. 259.
Fortschritte im **Lokomotiv- und Wagenbau** bei den senbahnen der Vereinigten Staaten im Jahre 1938/39. 500 Wörter & 7 Zusammenstellungen.)

1940 **656 .221**
asers Annalen, Heft 23, 1. Dezember, S. 231.
NORDMANN. — Der heutige Stand der **Zugwider-ndsformeln.** (12 000 Wörter.)

1940 **621 .135 .2**
asers Annalen, Heft 23, 1. Dezember, S. 245.
PAWELKA (E.). — Gegenseitig abhängige **Führungs-lachsen bei Lokomotiven.** (2 600 Wörter, 3 Zahlenln & Abb.)

1940 **621 .134 .2**
asers Annalen, Heft 23, 1. Dezember, S. 248; Heft 24, 15. Dezember, S. 255.
CHÖNING (P.). — Über das **Stumpfsche Kompres-sgesetz** unter besonderer Berücksichtigung der mechanischen Triebwerksreibung an Lokomotiv-Dampfmaschi-n. (4 800 Wörter, 1 Zahlentafel & Abb.)

Gleistechnik und Fahrbahnbau. (Karlsruhe.)

1941 **625 .14 (01**
Gleistechnik und Fahrbahnbau, Heft Nr. 5/6, 15. März, S. 17; Heft Nr. 7/8, 15. April, S. 25.
HANKER (R.). — Die Langträgerberechnung des **Eisenbahnoberbaues.** (5 000 Wörter, 1 Zusammenstellung & Abb.)

1941 **625 .142 .3 (.42)**
Gleistechnik und Fahrbahnbau, Heft Nr. 5/6, 15. März, S. 22.
Englische **Stahlschwellen.** (1 000 Wörter & Abb.)

1941 **625 .143 .5**
Gleistechnik und Fahrbahnbau, Heft Nr. 9/10, 15. Mai, S. 33; Heft 11/12, 15. Juni, S. 41.
HUBER (T.). — Über die **Verwerfungsgefahr eines geraden lückenlosen Gleises** im Zusammenhange mit der Stabilitätstheorie des elastisch eingebetteten schweren Stabes. (6 300 Wörter & Abb.)

1941 **625 .142 (.73)**
Gleistechnik und Fahrbahnbau, Heft 11/12, 15. Juni, S. 45.
Schwellenwirtschaft in den Vereinigten Staaten. (900 Wörter & Abb.)

1941 **625 .143 .4**
Gleistechnik und Fahrbahnbau, Heft 13/14, 15. Juli, S. 49.
WENTZEL. — Der **Schienenstoss.** (2 400 Wörter & Abb.)

1941 **625 .14 (01**
Gleistechnik und Fahrbahnbau, Heft 13/14, 15. Juli, S. 54.
PIHERA (H.). — Winkler und die **Oberbauberechnung.** (2 200 Wörter, 2 Zahlentafeln & Abb.)

1941 **625 .143 .5**
Gleistechnik und Fahrbahnbau, Heft 15/16, 15. August, S. 61.
HUBER (M. T.). — Über die Anwendung der Theorie zur Deutung der **Versuchsforschung im Gleisverwerfungsproblem.** (4 500 Wörter & Abb.)

1941 **625 .14 (01**
Gleistechnik und Fahrbahnbau, Heft 17/18, 15. September, S. 69.
PIHERA (H.). — Der Geschwindigkeitsbeiwert bei der **Oberbauberechnung.** (2 000 Wörter, 7 Tafeln & Abb.)

1941 **625 .143 .4**
Gleistechnik und Fahrbahnbau, Heft 19/20, 15. Oktober, S. 77; Heft 21/22, 15. November, S. 85; Heft 23/24, 15. Dezember, S. 93.
GROCHE (G.). — Zur **Einspannung der Schienenenden** auf Stossbrücken. (10 000 Wörter, Tabellen & Abb.)

1942 **625 .14. (01**
Gleistechnik und Fahrbahnbau, Heft 1/2, 15. Januar, S. 1; Heft 3/4, 15. Februar, S. 10; Heft 5/6, 15. März, S. 17.
SCHRAMM (G.). — **Oberbauberechnungen.** (6 500 Wörter, Zusammenstellungen & Abb.)

1942 **625 .14 (.489)**
Gleistechnik und Fahrbahnbau, Heft 1/2. 15. Januar. S. 8.
Ein **neuer Oberbau** der Dänischen Staatsbahnen. (400 Wörter.)

1942 **625 .14 (.45)**
Gleistechnik und Fahrbahnbau, Heft 5/6, 15. März, S. 21.
Vom italienischen **Oberbau.** (2 000 Wörter & Abb.)

Grossdeutscher Verkehr. (Berlin.)

1941 **656 (.43)**
Grossdeutscher Verkehr, Heft 2, Januar, S. 46.
KLEINMANN (W.). — Verkehrslenkung und Zusammenarbeit der **Verkehrsmittel.** (3 600 Wörter & Abb.)

1941 **385 .21 (.43)**
Grossdeutscher Verkehr, Heft 2, Januar, S. 56.
SPIESS & BÖHM. — Die **Zusammenarbeit** zwischen Reichsbahn und Binnenschiffahrt auf dem **Tarifgebiet.** (2 800 Wörter & Abb.)

1941 **625 .62 (.43)**
Grossdeutscher Verkehr, Heft 3, Februar, S. 84.
GÜNTHER GALLE. — Die deutschen **Strassenbahnen** im Rahmen des Personennahverkehrs. (4 000 Wörter & Abb.)

1941 **656 .132**
Grossdeutscher Verkehr, Heft 3, Februar, S. 92.
SCHUMANN (F.). — Betrachtungen zum **Autobusbau.** (2 800 Wörter & Abb.)

1941 **656 .235 .5 (.43) & 656 .236 .3 (.43)**
Grossdeutscher Verkehr, Heft 4, Februar, S. 125.
PLATZ. — Die **Seehafentarife** der Reichsbahn. (5 600 Wörter.)

1941 **625 .14 (01 & 625 .2 (01**
Grossdeutscher Verkehr, Heft 5/6, März, S. 150.
MJELICH. — **Rad, Schiene und Wagenlauf.** (8 000 Wörter & Abb.)

1941 **725 .31**
Grossdeutscher Verkehr, Heft 7, April, S. 172.
RÖTTCHER. — Die Eisenbahnen und die Gestaltung ihrer **Bahnhofshäusen.** (3 300 Wörter & Abb.)

1941 **624 .32 (.43) & 624 .62 (.43)**
Grossdeutscher Verkehr, Heft, 8, April, S. 208.
SCHAPER (G.). — Über den Bau von **Reichsbahn-** und **Reichsautobahn-Brücken** mit stählernem Überbau. (3 500 Wörter & Abb.)

1941 **624 (.43)**
Grossdeutscher Verkehr, Heft 8, April, S. 220.
PLARRE (K.). — Von den **Brücken** der Reichswasserstrassenverwaltung. (3 000 Wörter & Abb.)

Die Lokomotive. (Bielefeld-Berlin.)

1940 **385. (09 (.4**
Die Lokomotive, Nr. 9, September, S. 127.
MAEY (H.). — **Deutsche Eisenbahngeschichte** Spiegelbild der Reichswerdung. (2 700 Wörter & Abb.)

1940 **621 .3**
Die Lokomotive, Nr. 9, September, S. 133.
HANKO (H.). — **50-Hertz-Einphasen-Wechselstro Lokomotive** Bauart Krupp für schmalspurige (900 mm Industrie-(Abraum)-Bahnen. (1 000 Wörter & Abb.)

1940 **385. (09 (.8**
Die Lokomotive, Nr. 9, September, S. 135.
Die **Eisenbahnen** Kolumbiens. (500 Wörter & Karte.)

1940 **621 .131**
Die Lokomotive, Nr. 10, Oktober, S. 139.
MEINEKE (F.). — Über die **Beschränkung der Lok motivleistung durch die Umgrenzungslinie.** (2 400 W ter & Abb.)

1940 **385. (091 (.5**
Die Lokomotive, Nr. 10, Oktober, S. 143.
PINNE (A.). — Reiseeindrücke auf der **transiranisch Bahn.** (4 400 Wörter, 1 Karte & Abb.)

1940 **621 .133**
Die Lokomotive, Nr. 11, November, S. 153.
PFEIFER (H.). — Herabsetzung der Dampftempe turen bei **Heissdampflokomotiven.** (2 300 Wörter, 7 Z lentafeln & Abb.)

1940 **621 .13 (0 & 625 .14 (**
Die Lokomotive, Nr. 11, November, S. 157.
ECKHARDT (F.). — **Gleisfahrzeug und Oberb** (1 300 Wörter & Abb.)

Organ für die Fortschritte des Eisenbahnwese (Berlin.)

1940 **621 .392 (.43) & 624 (.**
Organ für die Fortschritte des Eisenbahnwesens, Heft 15. Juli. S. 234.
Wichtige Änderungen der Vorschriften für **geschweis Stahlbauten.** (400 Wörter.)

1940 **625 .23 (0 (.43) & 669 (.**
Organ für die Fortschritte des Eisenbahnwesens, H 15/16, 10. August, S. 237.
Dr. Ing. WIENS. — **Personenwagen in Leichtbau** (26 000 Wörter, Zahlentafeln & Abb.)

1940 **625 .232 (.43) & 669 (.**
Organ für die Fortschritte des Eisenbahnwesens, H 17/18, 10. September, S. 273.
TASCHINGER (O.). — **Leichtbau-D-Zugwagen** n dem Entwurf des Reichsbahnzentralamts Münch (17 000 Wörter, 2 Tabellen & Abb.)

1940 **625 .233 (.43) & 625 .234 (.43)**

gan für die Fortschritte des Eisenbahnwesens, Heft 17/18, 10. September, S. 297.

BAUR (H.). — **Heizung und Lichtstromversorgung** r Reichsbahn-Personenwagen in Leichtbauart. (5 600 örter, Zahlentafeln & Abb.)

1940 **625 .122**

gan für die Fortschritte des Eisenbahnwesens, Heft 19/20, 10. Oktober, S. 313.

KOLDEWITZ. — **Befestigung eines Bahndammes** in oorgebiet bei vollem Betrieb. (2 500 Wörter & Abb.)

1940 **656 .212 .5**

gan für die Fortschritte des Eisenbahnwesens, Heft 19/20, 10. Oktober, S. 319.

POTTHOFF. — Zur Ermittlung der **Höhe eines Ablaufrges** und der Neigung der Steilrampe. (500 Wörter Abb.)

1940 **656 .254 (.492)**

gan für die Fortschritte des Eisenbahnwesens, Heft 19/20, 10. Oktober, S. 320.

VERSTEGEN (J. H.). — Die **selbsttätigen Warnangen an Wegübergängen** auf eingleisigen Strecken der iederländischen Eisenbahnen. (1 700 Wörter & Abb.)

1940 **625 .14 (01**

gan für die Fortschritte des Eisenbahnwesens, Heft 19/20, 10. Oktober, S. 322.

PIHERA (H.). — **Oberbauberechnung.** (2 200 Wörter, Zusammenstellung & Abb.)

Die Reichsbahn. (Berlin.)

1940 **385 .517 (.43)**

ie Reichsbahn, Heft 51/52, 18./25. Dezember, S. 532.

THOMSEN. — Einrichtung und Organisation der **etriebs- und Werkküchenverpflegung** im Reichsbahnrektionsbezirk Essen. (2 800 Wörter & Abb.)

1941 **385 (.43)**

ie Reichsbahn, Heft 1, 1. Januar, S. 2.

Die **Deutsche Reichsbahn** im Jahre 1940. (1 800 Wörr.)

1941 **385 .582 (.43) & 656 .285 (.43)**

ie Reichsbahn, Heft 2/3, 8./15. Januar, S. 27.

MARTENS (Dr. H. A.). — **Unfallverhütung** der eutschen Reichsbahn im Bild. (4 500 Wörter.)

1941 **625 .212**

ie Reichsbahn, Heft 4/5, 22./29. Januar, S. 40.

SCHMIDT (F.) & BERNSDORFF. — Erfolge in der **adsatzbearbeitung durch Hartmetall.** (2 400 Wörter Abb.)

1941 **621 .431 .72**

e Reichsbahn, Heft 6/7, 5./12. Februar, S. 54.

GRETSCHEL & LANGENFELD. — Massnahmen bei erbrennungstriebwagen zur **Erhöhung der km-Laufleisngen** zwischen zwei Motorüberholungen. (1 200 Wörter Abb.)

1941 **385. (093 (.436)**

Die Reichsbahn, Heft 8/9, 19./26. Februar, S. 67.

FEILER (K.). — Das Archiv für Verkehrswesen in Wien als Forschungsinstitut für **Mitteleuropäische Eisenbahngeschichte.** (6 300 Wörter & Abb.)

1941 **625 .111**

Die Reichsbahn, Heft 12/13, 19./26. März, S. 98.

SPRÖGGEL. — **Eisenbahnbau als Gestaltungsaufgabe.** (4 000 Wörter & Abb.)

1941 **385 .113 (.43)**

Die Reichsbahn, Heft 22/23, 28. Mai/4. Juni, S. 192.

Geschäftsbericht der Deutschen Reichsbahn über das Geschäftsjahr 1940. (10 700 Wörter.)

1941 **385 .517 .4 (.43)**

Die Reichsbahn, Heft 22/23, 28. Mai/4. Juni, S. 213.

Dr. AUTENRIETH. — Die Durchführung der **Gemeinschaftsverpflegung** im Bezirk der Reichsbahndirektion Stuttgart. (1 800 Wörter & Abb.)

Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

1940 **665 .882**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 38, 21. September, S. 713.

KRUG (P.). — **Brennschneiden.** (1 200 Wörter, Zahlentafeln & Abb.)

1940 **621 .7**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 38, 21. September, S. 718.

LANGE (S.). — Dauerversuche an **Leichtmetallstäben mit einer aufgespritzten Stahlschicht.** (1 000 Wörter & Abb.)

1940 **621 .116**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 39, 28. September, S. 725.

VORKAUF (F.). — Heutiger Stand des **La Mont-Kesselbaues.** (3 200 Wörter, Zahlentafel & Abb.)

1940 **62. (01**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 39, 28. September, S. 733.

BERNHARDT (E. O.). — Die **Mikrohärteprüfung.** Anwendungsbeispiele aus der Technologie der **Kaltverformung.** (1 600 Wörter & Abb.)

1940 **621 .392**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 41, 12. Oktober, S. 777.

KRUG (P.). — **Kaltschweissung von Gusseisen.** (2 800 Wörter & Abb.)

1940 **625 .216**

Zeitschrift des Vereines deutscher Ingenieure, Nr. 42, 19. Oktober, S. 797.

SCHRÖDER (E.). — Die **selbsttätige Mittelpufferkupplung** für Eisenbahnfahrzeuge. (3 200 Wörter & Abb.)

1940 **62.** (01 & **669**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 43, 26. Oktober, S. 833.
Zusammenhang zwischen Eigenschaften und Verschleissfestigkeit von **Hartmetallegierungen.** (1 000 Wörter & Abb.)

1940 **621 .436**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 46, 16. November, S. 877.
SÖRENSEN (E.). — Strömungsfragen am **Dieselmotor.** (8 400 Wörter & Abb.)

1940 **691**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 46, 16. November, S. 891.
SCHAECHTERLE (K.). — **Werkstoffeinsparung** im Industriebau. (4 500 Wörter & Abb.)

Zeitung des Vereins Mitteleuropäischer Eisenbahnverwaltungen. (Berlin.)

1940 **385.** (09 (.52)
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 35, 29. August, S. 437.
von LOCHOW (H. J.). — Die **Südmandschurische Eisenbahn-Gesellschaft** das Gerüst Mandschukuos. (6 500 Wörter & Abb.)

1940 **625 .2** (01
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 36, 5. September, S. 449.
BÄSELER. — Zur Theorie des Kreiselwagens. (5 300 Wörter & Abb.)

1940 **621 .431 .72** (.489)
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 37, 12. September, S. 463.
KNUTZEN (P.). — Die **Motorisierung des Schienenverkehrs** der Dänischen Staatsbahnen. (3 500 Wörter & Abb.)

1940 **385.** (09 (.485)
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 38, 19. September, S. 475.
WERNEKKE. — Die **Lappland-Eisenbahn** Lulèa-Riksgränsen-Narvik. (4 000 Wörter & Abb.)

1940 **656 .237 .4**
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 38, 19. September, S. 480.
PRÄTZ. — Der **Ausgleich der Schulden und Forderungen** zwischen den Eisenbahnen aus den zwischenstaatlichen Güterverkehren. (1 300 Wörter.)

1940 **625 .162** (.43) & **656 .254** (.43)
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 39, 26. September, S. 487.
BUDDENBERG (A.). — Die **Sicherung der Wegübergänge** bei der Reichsbahn. (3 800 Wörter & Abb.)

1940 **656 .231** (.43)
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 40, 3. Oktober, S. 503.
SCHUBERT. — Die Änderungen des **Regelgütertarifaufbaus** zum 1. September 1940. (3 800 Wörter.)

1940 **385 .113** (.4
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 3. Oktober, S. 509.
Wirtschaftsergebnisse der Sowjetbahnen 1939. (9 Wörter.)

1940 **656 .285** (.4
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 10. Oktober, S. 513.
MARTENS (H. A.). — Die grosse Linie der **Person Unfallverhütung** bei der Deutschen Reichsbahn. (9 0 Wörter.)

1940 **385.** (09 (.59
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 10. Oktober, S. 523.
Die **Staatseisenbahnen** von Thai-Land. (700 Wör & Karte.)

1940 **656** (.49
Zeitung des Vereins mitteleur. Eisenbahnverw., Nr. 17. Oktober, S. 529.
REITSMA (S. A.). — Das Streben nach **Vereinhe lichung** im Niederländischen Verkehrswesen. (3 000 W ter.)

Zeitschrift für das gesamte Eisenbahn-Sicherungs- und Fernmeldewesen. (Berlin.)

1942 **656 .2**
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmel wesen, Nr. 12, September, S. 75.
GLÄSEL. — Über **Kontakte im Stellwerksbau.** (1 2 Wörter.)

1942 **656 .2**
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmel wesen, Nr. 12, September, S. 76.
BLASCHKE. — Zusätzliche **Flankenschutzeinrichtu gen** in besonderen Fällen. (500 Wörter & Abb.)

1942 **656 .25** (.43) & **656 .259** (.4
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmel wesen, Nr. 13, 10. Oktober, S. 85.
MORRASCH (Gg.). — **Sicherung von Gleisanschlüss** ausserhalb der Bahnhöfe bei wahlweiser Bedienu (1 000 Wörter & Abb.)

1942 **654** (.43) & **656 .211 .5** (.4
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmel wesen, Nr. 14/15, 20. November, S. 87; Nr. 10. Dezember, S. 100.
LINDNER (H.) und WEHMANN (H.). — Die **La sprecheranlage** des Hauptbahnhofs in München. (4 5 Wörter & Abb.)

1942 **656 .257** (.4
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmel wesen, Nr. 16, 10. Dezember, S. 97.
MORRASCH (Georg). — Der **Gruppenschalter** Befehlsblock. (1 000 Wörter & Abb.)

940/41/42/43 **656 .256 (.436)**
schr. für das ges. Eisenb.-Sicherungs- und Fernmeldewesen.
940, Nr. 4, 10. März, S. 29; Nr. 7, 20. Mai, S. 53; 14, 1. November, S. 110; 1941, Nr. 1, 10. Januar, ; Nr. 2, 1. Februar, S. 9; Nr. 4, 10. März, S. 31; 2, Nr. 2/3, 20. Februar, S. 9; Nr. 4, 10. März, S. 24; 5, Nr. 1, 10. Januar, S. 1; Nr. 2/3, 20. Februar, S. 12.
IESOK (W.). — Die **Sicherungs- und Streckenblockgen** österreichischer Bauart. (22 000 Wörter & Abb.)

In English.

Bulletin, American Railway Engineering Association. (Chicago.)

941 **693 (.73)**
etin, Amer. Railway Engineering Assoc., January, p. 295.
eport of Committee 8. **Masonry.** Composite columns pipe columns. Concrete manufacture. Specifications ining tunnels with metal liners and shotcrete. Culvert (specifications for placement). Pressure grouting. borings. Specifications for concrete under water. ability of concrete. (25 000 words & fig.)

941 **624 (.73)**
etin, Amer. Railway Engineering Assoc., January, p. 355.
eport of Committee 15. **Iron and steel structures.** sion of manual. Non-ballast type of metal floor steel ges. (4 000 words & fig.)

941 **625 .18 (.73)**
etin, Amer. Railway Engineering Assoc., January, p. 369.
port of Committee 11. **Records and accounts.** Stan- system for filing drawings. Office and drafting practices. Methods of avoiding duplication of reports for simplifying and coordinating work under the rements of the I. C. C. and other Public Authorities. (10 000 words.)

941 **624 .2 (.73) & 625 .14 (01 (.73)**
etin, Amer. Railway Engineering Assoc., January, p. 393.
port of special Committee on **Impact.** Description analysis of the bridge impact tests made by the sylvania RR. at Chester (comparison of impact s produced by steam and electric locomotives ut unbalanced weight in drivers, at speeds as high 5 m. p. h. (electric) and 90 m. p. h. (steam). New electric gauges used. (12 000 words, tabulations .)

941 **625 .142 .2 (.73) & 691 (.73)**
tin. Amer. Railway Engineering Assoc., February, . 489.
port of Committee 17. **Wood preservation.** Service records for treated ties. Piling used for marine ruction, etc. (5 000 words, tabulations & fig.)

1941 **385 .5 (.73) & 625 .1 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 515.
Report of Committee 12. **Rules and organisation.** Rules and regulations governing maintenance of way and structures employees (proposed revision). (12 000 words.)

1941 **625 .14 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 539.
Report of Committee 1. **Roadway and ballast.** Size of waterway openings; formulas; prevention of erosion. Vitrified clay pipe culverts; specifications. Pipe line crossings; specifications for non-inflammable substances under pressure. Formation of the roadway; settlement; shrinkage; subsidence. Placing materials in embankments. Tunnel lighting. Wood fence posts (specifications). Electrified fences. Design of signs. Size of ballast, etc. (15 500 words & fig.)

1941 **625 .14 (.73) & 625 .15 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 575.
Report of Committee 5. **Track. Fastenings** for continuous welded rail. Plans and specifications for track tools and recommended limits of wear. Plans for switches frogs, crossings, spring and slip switches. Bolt tension for proper supporting of rail joints. Lubrication of rails on curves. Prevention of damage due to brine drippings. Specifications for laying rails. Spirals for high-speed operation, etc. (20 000 words, plans & fig.)

1941 **625 .143 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 369.
Report of Committee 4. **Rail.** Revised forms for recording rail failures. Rail failure statistics (general failures, transverse fissures). Control-cooled and brunorized rails; rail battering and reconditioning. Continuous welding of rail. Service tests of various types of joint bars. Joint bar failures. Photoelastic investigation of design of joint bars, etc. (11 000 words, tabulations & fig.)

1941 **625 .143 .3 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 681.
MOORE (H. F.). — Seventh progress report of the joint investigation of **fissures in railroad rails.** (21 000 words, tables & fig.)

1941 **625 .14 (01 (.73)**
Bulletin Amer. Railway Engineering Assoc., February, p. 753.
Report of special Committee on **stresses in railroad track.** (7th progress report.) (2 000 words.)

Engineer. (London.)

1945 **656 .253 (.42)**
Engineer, No. 4690, November 30, p. 447.
L. N. E. R. **signal gantry** at Sheffield. (300 words & fig.)

1945 **621 .132 .8 (.73)**
Engineer, No. 4691, December 7, p. 466.
American geared **turbine steam locomotive.** (2 700 words & fig.)

1945 **621 .87 (.42) & 621 .436 (.42)**
Engineer, No. 4692, December 14, p. 493.
A diesel engine driven **crane.** (800 words & fig.)

1945 **621 .132 .3 (.42)**
Engineer, No. 4693, December 21, p. 512; No. 4694, December 28, p. 530.
BULLEID (O. V. S.). — S. R. « **Merchant Navy** » **class locomotives.** (4 900 words & fig.) (To be continued.)

1945 **621 .87 (.42)**
Engineer, No. 4694, December 28, p. 525.
Heavy-duty level luffing grab **cranes.** (3 050 words & fig.)

1946 **621 .13 (.42)**
Engineer, No. 4695, January 4, p. 16; January 11, p. 42.
Railway **locomotives** of 1945. (3 600 words & fig.)

1946 **725 .33 (.42)**
Engineer, No. 4699, February 1, p. 103.
An L. M. S. Railway motor vehicle **workshop.** (1 500 words & fig.)

1946 **621 .13 (06 (.42) & 621 .132 .3 (.42)**
Engineer, No. 4700, February 8, p. 135.
The **Institution of Locomotive Engineers.** (2 500 words.)

1946 **621 .132 .8 (.42)**
Engineer, No. 4700, February 8, p. 136.
BOND (R. C.). — L. M. S. **turbine locomotive.** (6 300 words & 2 tab.)

1946 **621 .134 .3**
Engineer, No. 4701, February 15, p. 145; No. 4702, February 22, p. 168; No. 4703, March 1, p. 192.
HOLCROFT (H.). — **Conjugated valve gears** for locomotives: their history and development. (6 800 words & fig.)

1946 **621 .132 .5**
Engineer, No. 4701, February 15, p. 147.
The **eight-coupled locomotive.** (900 words.)

Engineering News-Record. (New York.)

1940 **725 .43 (.73)**
Engineering News-Record, November 7, p. 725.
Windowless factory building with **pressure dust-proof ventilation** and **fluorescent lighting** (manufacture of diesel engines). (2 000 words & fig.)

1940 **625 .13 (.492)**
Engineering News-Record, November 7, p. 50.
VAN BRUGGEN (J. P.). — **Precision device for sinking tunnel caissons** (under River Maas, Rotterdam). (1 500 words & fig.)

1940 **625 .13 (.73)**
Engineering News-Record, November 7, p. 60.
Fast **tunnel driving** at Carlton (1 879 ft. from a single portal heading in 31 days.) (2 800 words & fig.)

1940 **624 .1 (**
Engineering News-Record, November 7, p. 65.
OSLER (John H., Jr.). — Shore-built launched bra units cut **cofferdam costs.** (1 600 words & fig.)

1940 **624 (0 (.73) & 624 .51 (**
Engineering News-Record, November 21, p. 44.
BOWERS (N. A.). — Model tests showed aerodyn unstability of Tacoma Narrows **bridge.** (2 800-ft. sl (2 700 words & fig.)

1940 **624 .1 (**
Engineering News-Record, November 21, p. 54.
WHITCOMB (Louis K., Jr.). — Z-piling filled concrete for **bridge pier shafts** (Dover, Ohio.) (words & fig.)

Journal, Institute of Transport. (London.

1943 **656**
Journal, Institute of Transport, October, p. 653.
Sir William V. WOOD. — The threshold of a era in **transport.** (3 000 words.)

1943 **656 .224**
Journal, Institute of Transport, October, p. 663.
KLAPPER (C. F.). — Some aspects of **suburban way operation.** (1 500 words.)

1944/1945 **656 .234**
Journal, Institute of Transport, May, p. 756; Au p. 810; November, p. 36; August-September p. 146.
LEE (Ch. E.). — **Passenger class distinctions:** I. V men's fares; II. The development of three cl III. Parliamentary fares and third-class travel; V ductions of classes. (8 000 words & tables.)

1944 **656**
Journal, Institute of Transport, August, p. 790.
BONAVIA (M. R.). — **Traders and a second « ways Act ».** (3 000 words.)

1944 **656**
Journal, Institute of Transport, August, p. 801.
GOSSELIN (C. le M.). — Some thoughts on pos planning of **inland transport.** (1 500 words.)

1944 **385. (06 (.42) & 656 (06**
Journal, Institute of Transport, November, p. 10.
LAMB (D. R.). — The **Institute of Transpor** beginnings and achievements. (7 000 words & fig.)

1945 **656**
Journal, Institute of Transport, May-June, p. 90.
Sir Cyril HURCOMB. — The **co-ordination of tra** in Great Britain during the years 1935-1944. words.)

1945 **656**
Journal, Institute of Transport, May-June, p. 109.
PARKE (J. F.). — **Co-ordination** of air and s transport. (1 000 words.)

945 **656 .1 (.42)**
rnal, Institute of Transport, August-Sept., p. 127.
ICHOLL (J. S.). — The post-war development of **l motor transport**; traffic. (3 000 words.)

ournal, Institution of Engineers, Australia. (Sydney, N. S. W.)

940 **721 .1**
rnal, Institution of Engineers, Australia, No. 1, January, p. 21.
LYNN (D. F.). — A review of **soil mechanics** and application to civil engineering. (5 000 words & fig.)

940 **624 .63 (.944)**
rnal, Institution of Engineers, Australia, No. 2, February, p. 65.
OOK (F. C.) & COVER (B. E.). — Reinforced **crete highway bridges** in New South Wales. (7 200 ds & fig.)

940 **62. (01 & 669**
rnal, Institution of Engineers, Australia, No. 3, March, p. 102.
IRST (H.). — The application of X-Ray powder tography to the **investigation of alloys.** (5 000 words g.)

940 **62. (01 & 669**
rnal, Institution of Engineers, Australia, No. 5, May, p. 147.
OAS (W.). — The effect of crystalline structure on **properties of metals.** (2 000 words & fig.)

940 **656 .222 .5 (.945)**
rnal, Institution of Engineers, Australia, No. 9, September, p. 247.
SHWORTH (J. M.). — The **suburban railway system** Melbourne. Its problems and their solution. (4 000 ds & fig.)

941 **624 .8 (.942)**
rnal, Institution of Engineers, Australia, No. 3, March, p. 57.
cMAHON (J. P.). — The construction of the Birnead **bridge.** (6 000 words, tables & fig.)

941 **624 .2**
rnal, Institution of Engineers, Australia, No. 6, June, p. 131.
URN (A.). — **The effect of deflection of the support-beams** on the bending moments in a uniformly loaded . (3 000 words & fig.)

941 **62. (01 & 691**
rnal, Institution of Engineers, Australia, No. 8, August, p. 181.
NDREWS (K. E.). — **Proportioning of concrete** with ial reference to the grading of aggregates. (4 000 ds & fig.)

941 **624 .2**
rnal, Institution of Engineers, Australia, No. 11, November, p. 255.
ZANNE (W. A.). — The solution of **continuous us** of variable moment of inertia by arithmetical mation. (2 000 words, tables & fig.)

1941 **621 .392 (.946)**
Journal, Institution of Engineers, Australia, No. 12, December, p. 279.
ISAACS (D. V.). — Design of **welded steelwork** in Bridgewater Bridge, Tasmania. (3 000 words, tables & fig.)

Modern Transport. (London.)

1945 **621 .33 (.44)**
Modern Transport, August 4, p. 9.
French **railway electrification.** Achievements and prospects. Paris-Dijon quadrupling. (1 400 words & fig.)

1945 **625 .243 (.71)**
Modern Transport, August 4, p. 15.
Aluminium freight cars. Experiment on Canadian Pacific Railway. (400 words & fig.)

1945 **621 .431 .72 (.73)**
Modern Transport, August 11, p. 9.
Well-known **American trains.** Pointers to the future. (1 000 words & fig.)

1945 **621 .132 .3 (.42)**
Modern Transport, August 18, p. 3.
New **4-6-0 locomotive** for the G. W. R. First Hawksworth design. Welded tender construction. (800 words & fig.)

1945 **625 .42 (.47)**
Modern Transport, August 18, p. 5.
Expanding the Moscow **Metro.** Belt line construction. Deep level tunnels. (600 words & fig.)

1945 **621 .335 (.494)**
Modern Transport, August 18, p. 15.
New locomotives on the Lötschberg Railway. Double bogie express type. (500 words & fig.)

1945 **621 .133 .3**
Modern Transport, August 18, p. 16.
Collapse of a firebox crown. Failure to observe water level. (1 200 words.)

1945 **621 .132 .3 (.42)**
Modern Transport, August 25, p. 5.
L. N. E. R. **locomotive conversion.** Two-cylinder rebuilt of K3 class. (200 words, table & fig.)

Railway Age. (New York.)

1940 **625 .232 (.73) & 656 .222 (.73)**
Railway Age, November 16, p. 708.
Passenger progress scores most outstanding year. (General review, with tabulations, of progress made in 1940 as regards passenger trains.) (8 500 words, tables & fig.)

1940 **656 .222 (.73)**
Railway Age, November 16, p. 719.
March of the streamliners (characteristics and statistics on most of the new streamliners). (Tabulations and fig.)

1940 **625 .232 (.73) & 656 .22 (.73)**
Railway Age, November 16, p. 737.
Modernized trains (as compared with the new streamliners). (3 000 words & fig.)

1940 **625 .232 (.73) & 625 .235 (.73)**
Railway Age, November 16, p. 743.
Modern **passenger cars** built around the passenger. A review of the structural materials (light-weight) used, the accommodation and comfort provided, etc. Tabulations. (1 500 words & tables.)

1940 **625 .14 (.73) & 656 .222 .1 (.73)**
Railway Age, November 16, p. 748.
High speeds demand good track. (4 000 words & fig.)

1940 **656 .25 (.73)**
Railway Age, November 16, p. 752.
Faster trains require **modern signalling.** (5 000 words & fig.)

1940 **656 .23 (0 (.73) & 659 (.73)**
Railway Age, November 16, p. 756.
The **passenger must be sold** (a review of means resorted to bring back traffic). (4 000 words & fig.)

1940 **625 .232 (.73) & 656 .222 .1 (.73)**
Railway Age, December 21, p. 930.
From Michigan Boulevard to Biscayne Bay (Miami) in 29 1/2 hours (by means of the « Dixie Flagger », the « City of Miami » and the « South Wind »). A description of the **trains.** (9 500 words, table & fig.)

1940 **624 .52 (.73)**
Railway Age, December 21, p. 946.
Cantilever introduced in simple-truss bridge to increase its length, at Krotz Springs (Missouri-Pacific). (2 600 words & fig.)

1940 **656. 257 (.73)**
Railway Age, December 21, p. 949.
Michigan Central installs new **interlockings** at Windsor, Ont. Modern entrance-exit and miniature lever all-relay control systems level control machines with mechanical locking. (4 800 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

1940 **621 .392 (.73) & 624 .2 (.73)**
Railway Engineering and Maintenance, August, p. 500.
SMITH (Floyd R.). — **Welded girder bridge** prefabricated set in five hours on the Union Railroad. (5 000 words & fig.)

1940 **625 .144 .2 (.73) & 625 .156 (.73)**
Railway Engineering and Maintenance, August, p. 504.
Getting more service from **curve lubricators** (Chesapeake and Ohio). (2 500 words & fig.)

1940 **621 .151 (.73)**
Railway Engineering and Maintenance, August, p. 506.
KULP (B. R.). — **High-speed turnouts.** Design, construction, maintenance. (3 000 words & fig.)

1940 **625 .142 .2 (.**
Railway Engineering and Maintenance, August, p.
Splits in ties. How they can be controlled ? (2
words & fig.)

1940 **721 .7 (.**
Railway Engineering and Maintenance, August, p.
SPARKS (A. L.). — What **kind of floor** (for s
and large stations) ? (2 900 words & fig.)

1940 **691 (.73) & 694 (.**
Railway Engineering and Maintenance, August, p.
Alton and Southern **treats lumber and timber v**
Wolman salts (sodium fluoride, **arsenate,** dinitro-ph
and neutralizing chromates). (2 200 words & fig.)

1940 **625 .13 (.**
Railway Engineering and Maintenance, October, p.
Power tools save money on long **deck renewal**
(Canadian National Rys.). (2 100 words & fig.)

1940 **694 (.**
Railway Engineering and Maintenance, October, p.
Coast Lines of the Southern Pacific use Douglas
plywood in building construction, alteration and re
work. (1 000 words & fig.)

1940 **625 .1 (06 (.**
Railway Engineering and Maintenance, October, p.
Roadmasters hold near-record Convention at Chic
Subjects discussed: The simplification of track wo
Handling snow and ice; Maintenance of gage for tod
higher speeds; Effect of weight of rail on track m
tenance; Ditching and bank widening; Welding, its
in track work; Slow orders. (50 000 words & fig.)

Railway Gazette. (London.)

1945 **385. (01 & 621 .13**
Railway Gazette, No. 22, November 30, p. 556.
BULKELEY (G. V. O.). — **Locomotives** for colo
railways. (3 200 words.)

1945 **625 .14 (01 & 62**
Railway Gazette, No. 22, November 30, p. 564.
The **movements of railway vehicles on the tracks**
the forces arising therefrom. (2 500 words.)

1945 **621 .132 .5 (.**
Railway Gazette, No. 22, November 30, p. 565.
New **steam locomotives** for Swedish State Railw
(1 100 words & fig.)

1945 **656 .25 (.**
Railway Gazette, No. 22, November 30, p. 566.
Restoration of French **signalling installations.** (2
words & tables.)

1945 **385 .113 (.**
Railway Gazette, No. 22, November 30, p. 577.
The **Swedish State Railways** in 1944. (700 words.)

1945 **621 .132 .5 (.**
Railway Gazette, No. 23, December 7, p. 591.
A **locomotive rebuilt** in Nigeria. (400 words & fig.)

1945 **614 .8 (.73) & 621 .33 (.73)**
ilway Gazette, No. 23, December 7, p. 592.
Fire fighting hazards on **electrified lines.** (1 800 words fig.)

1945 **656 .211 .5 (.42)**
ilway Gazette, No. 24, December 14, p. 613.
L. N. E. R. new type of **train indicator.** (1 100 words fig.)

1945 **621 .132 .3 (.460)**
ilway Gazette, No. 24, December 14, p. 615.
New **4-8-2 type locomotives** in Spain. (900 words & fig.)

1945 **621 .135 .2 (.42) & 625 .214 (.42)**
ilway Gazette, No. 24, December 14, p. 616.
Roller **bearing axleboxes.** Improved methods for lubrint retention. (800 words & fig.)

1945 **625 .42 (.42)**
ilway Gazette, No. 24, December 14, p. 617.
Building the inner Circle Railway. (800 words & fig.)

1945 **656 .283 (.42)**
ilway Gazette, No. 24, December 14, p. 626.
Ministry of War Transport **accident report.** Haywards ath, Southern Railway: September 2, 1945. (3 200 rds & fig.)

Railway Mechanical Engineer. (New York.)

1940 **621 .335 (73), 621 .431 .72 (.73) & [625 .232 (.73)**
ilway Mechanical Engineer, December, p. 523.
« Southern Belle » 4-car **diesel-electric trains** built of minium alloys, Kansas City Southern-Louisiana Arkansas Lines. (2 000 words & fig.)

1940 **621 .131 .1 (.73) & 621 .131 .3 (.73)**
ilway Mechanical Engineer, December, p. 526.
BOTTERON (L. K.). — **Cylinder power measurement.** nitations of mechanical indicators in determining the H. P. of high-speed locomotives. Heat-drop method ployed by the Union Pacific in road tests. (1 700 rds.)

1940 **625 .243 (.73)**
ilway Mechanical Engineer, December, p. 528.
Light-weight all-welded 50-ton box cars, C. M. St. & P. Double deck loading, special fabricated steel or plates. (800 words & fig.)

1940 **62 (01 (.73) & 621 .133 .2 (.73)**
ilway Mechanical Engineer, December, p. 531.
Factors influencing the service of **firebox materials.** ing properties, surface strength and effect of tempeure. Use of alloying elements, particularly molybden. (2 000 words & fig.)

1940 **625 .25 (.73) & 625 .26 (.73)**
ilway Mechanical Engineer, December, p. 550.
BIRCH (T. H.). — **Pipe and air-brake shop devices.** 000 words & fig.)

In Spanish.

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1940 **621 .33**
Ferrocarriles y Tranvias, septiembre, p. 266; noviembre, p. 330.
MARIO VIANI. — Conferencias sobre **tracción eléctrica.** (Continuación.) (6 000 palabras & fig.)

1940 **385 (.44)**
Ferrocarriles y Tranvias, septiembre, p. 277.
HARCAVI (G.). — El **problema ferroviario** francés. (3 500 palabras.)

1940 **656 .136**
Ferrocarriles y Tranvias, noviembre, p. 342.
LOPEZ JAMAR (L.). — Desarrollo y reglementación del **trolebús** en los principales países europeos. (3 500 palabras & fig.)

1940 **385 .1**
Ferrocarriles y Tranvias, noviembre, p. 352; diciembre, p. 378.
JIMENEZ ONTIVEROS (F.). — Sobre un método científico para el estudio de la **economía ferroviaria.** (10 500 palabras & fig.)

1940 **621 .431 .72 (.494)**
Ferrocarriles y Tranvias, diciembre, p. 362.
MARIANO BASTOS. — **Locomotoras Diesel-eléctricas** de los ferrocarriles suizos. (3 600 palabras & fig.)

1940 **625 .3 & 621 .431 .72**
Ferrocarriles y Tranvias, diciembre, p. 371.
Problemas de tracción en los **ferrocarriles de montaña.** (3 500 palabras & fig.)

1941 **313 .385 (.460)**
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NOGUES (J.). — Nuestras **explotaciones ferroviarias** al traves de la estadística comparada. (6 000 palabras.)

1941 **385 .15 (.460) & 656 (.460)**
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Ley de bases de **ordenación ferroviaria** y de los transportes por carretera de 24 de enero de 1941. (4 500 palabras.)

1941 **385 (.460)**
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ALEIXANDRE (A. MA.). — Trabajos de la **unificación de material** a partir de la liberación de España. (2 800 palabras.)

1941 **621 .135. (01, 625 .14 (01 & 625 .2 (01**
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LOPEZ JAMAR (L.). — Introducción al estudio de las **relaciones entre el vehículo y la vía.** (5 200 palabras & fig.)

1941 **625 .143 .4**

Ferrocarriles y Tranvias, abril, p. 90.
FABREGAS (M.). — Defectos que presentan los **juntas** en las vías férreas y medios para aminorarlos. (2 200 palabras & fig.)

1941 **656 .231**

Ferrocarriles y Tranvias, abril, p. 94.
MACIAS (M.). — **Tarificación** ferroviaria. (5 000 palabras & fig.)

1941 **621 .33**

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SERRET y MIRET (Ramon MA). — **Electrificación** de ferrocarriles. (7 000 palabras & fig.)

1941 **385 .4**

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SANCHEZ-MORENO (R.). — **Dirección y Administración** de empresas ferroviarias. (7 400 palabras.)

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1942 **621 .132 .5 (.460)**

Revista de Obras Públicas, nº 2732, 1 de diciembre, p. 616.
Locomotoras tipo « Santa Fe » (2-10-2, números 5.001 al 5.020) de la R. E. N. F. E. (1 700 palabras & fig.)

1943 **629 .113 .62 (.460) & 656 .136 (.460)**

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RODRIGUEZ (José MA Cano). — Construcción y explotacion de **trolebuses** en Espana. (1 800 palabras & fig.)

1943 **625 .113**

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GARCIA GONZALEZ (Fermin). — Simplificación de los **problemas de acuerdo en vias** y explanaciones. (3 000 palabras & fig.)

1943 **624 .6**

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ALLUE CHICO (Ricardo). — Algunas aplicaciones de la exponencial $e^{\alpha \varphi + \varepsilon}$ al calculo de **arcos.** (1 500 palabras & fig.)

1943 **624 ,63 & 721**

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SOTO BURGOS (José). — La **translación de los nudos** y las aproximaciones sucesivos. (2 000 palabras & fig.)

1943 **624 .2 (.460) & 691 (.460)**

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Nº 2734, 1 de febrero, p. 57;
Nº 2735, 1 de marzo, p. 113;
Nº 2736, 1 de abril, p. 165;
Nº 2737, 1 de mayo, p. 200;
Nº 2738, 1 de junio, p. 261;
Nº 2739, 1 de julio, p. 312;
Nº 2740, 1 de agosto, p. 361;
Nº 2741, 1 de septiembre, p. 419.
Nº 2742, 1 de octubre, p. 462.
LUIS MUSQUIZ (José). — **Puentes de hormigón para ferrocarril** (estudio basada en la experiencia de nuestra guerra). (18 000 palabras, cuadros & fig.)

1943 **621 .**

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Calculo de tablas de tensada de sustentadores de
linea de contacto à 3 000 voltios (de la Revista Tecn
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1943 **625 .23 (.43) & 625 .24 (.**

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Novedades en la construcción de **coches de viajeros vagones de mercancías** de los ferrocarriles alemanes (de
Revista Transit, marzo de 1942). (3 700 palabras & fi

1943 **62. (01 & 624**

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MENDIZABAL (D.). — Nuevos aparatos para **ensa de construcciones metálicas.** (1 500 palabras & fig.)

1943 **691 & 721**

Revista de Obras Públicas, nº 2742, 1 de octubre, p. 4
VIADER MUNOZ (A.) y BARCELO (G.). — C
veniencia de vibrar los **hormigones** en las estructu
de hormigón armado. (1 800 palabras & fig.)

1943/1944 **624 .63 (.46**

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p. 500; nº 2746, 1 de febrero, p. 75.
VILLALBA GRANDA (C.). — El **puente** del Pedri
(14 000 palabras & fig.)

1943 **624**

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p. 543.
ARACIL (J. J.). — **Vigas de madera** compue
unidas con clavos. (1 500 palabras & fig.)

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1940 **625 .1 (.**

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Il **nuovo tronco** Castelnuovo di Carfagnana-Piazza
Serchio delle ferrovia Lucca-Aulla. (7 000 parole, ta
& fig.)

1940 **624 .32 (.**

Annali dei lavori pubblici, dicembre, p. 1039.
Il **ponte** sul Canalbianco per la ferrovia Adria-Ari
Polesine. (600 parole & fig.)

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1941

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SANTARELLI (L.). — **Cementi ferrici** a basso moc
calcare. (6 000 parole, 10 tabelle & fig.)

1941 **621 .431 .72 (.**

L'Ingegnere, nº 1, 15 gennaio, p. 43.
FARAGGIANA (E.). — Sul problema dei **gassog**
(3 000 parole & fig.)

1941 **62. (01**

'Ingegnere, nº 2, 15 febbraio, p. 131.
MATTIAZZO (F.). — Sulle **linee d'influenza** ottenute me deformate mediante distorsione. (2 500 parole fig.)

1941 **621 .431 .72 (.45)**

'Ingegnere, nº 7, 15 luglio, p. 637.
ALESSIO (A.). — Le nuove **automotrici articolate** r le Strade ferrate del Mediterraneo. (5 000 parole fig.)

1941 **62. (01 & 721 .9**

'Ingegnere, nº 8, agosto, p. 748.
LANNUTTI (P.). — Varianti postume nelle ossature **cemento armato.** (3 000 parole & fig.)

1941 **624 .2**

'Ingegnere, nº 8, agosto, p. 781.
MATTIAZZO (F.). — **Sistemi iperstatici** ed ellisse di asticità. (4 500 parole & fig.)

1941 **656 .211 (.45)**

'Ingegnere, nº 9, settembre, p. 849.
MATERNINI (M.). — La nuova **stazione** di Roma stiense. (1 000 parole & fig.)

1941 **62. (01 & 693**

'Ingegnere, nº 11, novembre, p. 993.
La condotta delle **prove sui cementi** nell' esame comrativo di quattro laboratori. (2 000 parole, 9 tabelle fig.)

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1940 **625 .143 .1 (.45)**

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APICELLA. — Le **rotaie normali** e quelle speciali delle errovie dello Stato Italiano. (3 500 parole & fig.)

1940 **625 .251**

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MONTELUCCI (R.). — Contributo alle determinazioni lla **frenatura** dei convogli ferroviari. (3 600 parole fig.)

1940 **656 .254**

ivista tecnica delle ferrovie italiane, 15 agosto, p. 53.
PACETTI (G.). — **Radiocomunicazioni** fra posti fissi convogli viaggianti. (3 000 parole & fig.)

1940 **385. (06 .4 (.45)**

vista tecnica delle ferrovie italiane, 15 agosto, p. 65.
SARTI (G.). — La **Mostra per il Centenario** delle errovie Italiane: 1839-1939. (3 600 parole & fig.)

1940 **625 .26 (.45)**

vista tecnica delle ferrovie italiane, 15 settembre, p. 85.
MORGANA (M.). — Il **parco vetture** di Roma-Prestina. (4 000 parole & fig.)

1940 **621 .333 (.45)**

Rivista tecnica delle ferrovie italiane, 15 settembre, p. 101.
VALLINI (A.). — Comportamento del **motore trifase** ad induzione alimentato da un sistema trifase asimmetrico di tensioni. (1 500 parole & fig.)

1940 **385. (06 .4 (.45)**

Rivista tecnica delle ferrovie italiane, 15 settembre, p. 107.
VALERI (C.). — Le **Ferrovie dello Stato** alla XXII Fiera di Padova. (2 500 parole & fig.)

In Dutch.

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1941 **698**

De Ingenieur, Nr 16, 18 April (bijlage), p. Mk. 19.
CANNEGIETER (D.). — Toepassingen van kunstharsen, welke leiden tot **besparing van drogende oliën en vluchtige oplosmiddelen.** (6 500 woorden & fig.)

1941 **621 .33**

De Ingenieur, Nr 17, 25 April, p. V. 5.
Wereldkracht-Congres 1938. Congresverslag betreffende de **energie-voorziening van electrische spoorwegen.** (7 000 woorden.)

1941 **625 .13 (.492)**

De Ingenieur, Nr 17, 25 April, p. B. 49.
WOLTERBEEK (C.). — De **tunnels** te Velsen. (7 000 woorden & fig.)

1941 **625 .13 (.492)**

De Ingenieur, Nr 18, 2 Mei, p. B. 57.
HOOS (J.). — De **Maastunnel** te Rotterdam. (8 000 woorden & fig.)

1941 **669 .1 & 691**

De Ingenieur, Nr 24, 13 Juni, p. W. 39.
SCHOTTE (E.). — Chemische **oppervlaktebehandeling van staal.** (3 200 woorden.)

1941 **625 .13 (.492)**

De Ingenieur, Nr 27, 4 Juli, p. B. 107.
LASSEN NIELSEN. — De **Maastunnel** te Rotterdam. Het bouwen en doen zinken der negen tunnelstukken. (3 000 woorden & fig.) (Wordt vervolgd.)

Spoor- en Tramwegen. (Utrecht.)

1940 **621 .13 (09 (.492)**

Spoor- en Tramwegen, Nr 21, 12 October, p. 415.
LABRIJN (P.). — De **oude locomotieven** der N. C. S. (800 woorden, 4 tabellen & fig.)

1940 **625 .142 .4 (.493) & 691 (.493)**

Spoor- en Tramwegen, Nr 21, 12 October, p. 421.
DOUTRELINGNE (E.). — De **creosoteerwerf** te Wondelgem (Gent.) (2 000 woorden & fig.)

1940 **385. (09 (.92)**

Spoor- en Tramwegen, Nr 22, 26 October, p. 435; Nr 23, 9 November, p. 461.

DE BRUYN KOPS (A. L.). — De **Ringbaan** in en om Batavia. (4 300 woorden & fig.)

1940 **625 .144 .2**

Spoor- en Tramwegen, Nr 22, 26 October, p. 440.

BRANDSMA (F.). — Fout in het **berekenen van overgangsbogen.** (1 000 woorden & fig.)

1940 **385**

Spoor- en Tramwegen, Nr 22, 26 October, p. 444.

GROENEVELT (H. J.). — Het verband tusschen **spoorwegaanleg** en **algemeene economische ontwikkeling.** (1 200 woorden & fig.)

1940 **385 .15 (.485)**

Spoor- en Tramwegen, Nr 23, 9 November, p. 457.

De naasting der **particuliere spoorwegen** in Zweden. (1 200 woorden, 2 tabellen & kaart.)

1940 **621 .33 (.4**

Spoor- en Tramwegen, Nr 24, 23 November, p. 477.

De beteekenis der **spoorwegelectrificatie** voor Zwit land. (800 woorden & fig.)

1940 **621 .13 (09 (.4**

Spoor- en Tramwegen, Nr 25, 7 December, p. 495.

LABRIJN (P.). — De **oudste H. IJ. S. M.-locomo ven** voor noormaal spoor. (1 800 woorden, tabellen & f

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1940 **656 .253 (.4**

Spoor- en Tramwegen, Nr 25, 7 December, p. 505.

VAN AALDEREN (H. J.). — Toepassing van **ba voor hoofdseinpalen,** waarvan de voorseinarmen zijn a gebracht onder een anderen hoofdseinarm. (1 000 woor & fig.)

1940 **656 .211 (.**

Spoor- en Tramwegen, Nr 25, 7 December, p. 507.

STUVEL (H. J.). — **Nieuw Station** te Rome. (1 woorden & fig.)

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